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OPTIMAL PAYMENT CONTRACTS IN TRADE RELATIONSHIPS*

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In buyer–seller relationships, offering trade credit to buyers fosters long-term collaboration but seller provision varies systematically as relationships evolve. We study the optimal provision dynamics of trade credit when the seller's information about the buyer is incomplete. We show how the interaction of self-enforcing relational contracts and formal contracts determines optimal payment contract choice. We find that payment contracts can be interpreted as screening technologies and imply distinct learning opportunities about the buyer's type. In line with empirical evidence, the model predicts that all transitions between payment terms lead to seller trade credit provision in the long run.

1. INTRODUCTION

A limited enforceability of formal contracts is a recurring challenge to the success of buyer–seller transactions. Payment contracts provide firms with a tool to shift the risks of contract noncompliance between trade partners. Relative to the date of shipment, these define the timing according to which the buyer must pay the seller for traded products. On the one side, the seller can request cash in advance, which eliminates the seller's risk of not receiving payment for products already delivered but exposes the buyer to the residual risk of not receiving the seller's shipment. Conversely, the seller can offer open account payment terms, in which case, the buyer needs to pay only after product arrival. This causes a reversion of the residual noncompliance risk between the buyer and the seller. In international trade, these risks are economically particularly relevant since the shipment of products over longer distances and across borders costs time. This implies that the choice of payment contracts goes hand-in-hand with a financing decision over the working capital involved in a transaction and, correspondingly, a decision over the provision of trade credit. Banks and insurance firms offer a comprehensive set of trade finance products that allow to reduce or eliminate the residual risks of contract noncompliance.[1] However, the share of global trade falling under their coverage is

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[1] An overview on the most relevant products in international trade finance can be found in U.S. Department of Commerce (2012).

limited and a substantial share of firms rely on nonintermediated payment modes despite the ubiquitous challenge of institutional enforcement deficiencies.[2]

This self-sufficiency suggests a strong reliance of trade partners on informal, relational mechanisms to ensure contractual performance. A large literature documents that establishing long-termed, trustful trade relationships can help firms to overcome the obstructions of weak institutions and guarantee contractual performance.[3] At the same time, empirical evidence obtained in recent research points at a mutual dependence of the payment contract choice of firms and the sustained success of trade relationships. Antràs and Foley (2015) and Garcia-Marin et al. (2020) show that although payment terms powerfully predict the stability of trade relationships, their choice varies systematically with relationship age. They document that the provision of trade credit by sellers has a substantial positive impact on the stability of buyer–seller trade relationships, and their robustness to economic shocks. Moreover, although in a large share of new relationships, payment is made in advance of shipment, sellers proceed to offer open account terms more frequently and provide larger amounts of trade credit to buyers as their relationships mature.

In order to explain these patterns, we propose a first relational contracting model of payment contract choice. Our analysis provides novel microfoundations for the highlighted empirical patterns and shows that their validity crucially depends on the quality of information transmission between trade partners and enforcement institutions in the buyer's economy. We set up a model of repeated trade between a buyer and a seller who can sign contracts on individual transactions with limited enforceability. We investigate how relational incentives interact with the seller's choice of the trade volumes and the payment terms of transactions when information over the buyer's type is incomplete. We analyze how a payoff-maximizing seller can design stage contracts and adjust them over the course of the trade relationship to resolve contractual and informational frictions optimally.

In a first step, our study shows that payment contracts impact the stability of trade relationships by providing the seller with distinct learning opportunities over the buyer's type. Payment contracts can be interpreted as *screening technologies* and we find that the seller's information acquisition about the buyer's type is faster under cash-in-advance terms compared to open account terms. Whereas under the former, it is optimal for the seller to propose a stage contract that immediately separates buyers in new trade relationships, under open account terms, the optimal contract pools buyer types and as a consequence information acquisition is more gradual. In order to understand this outcome, note first that the buyer's type relates to her discount factor and either she is fully myopic or patient. The type is fixed and the buyer's private information. Second, we assume that time elapses between the seller's investment in production and the buyer's revenue realization from product distribution to final consumers, making the buyer's type decisive for contract compliance.

The separating nature of cash-in-advance contracts implies a lower stability of trade relationships as these are only accepted by patient buyers. In established relationships, cash-in-advance terms also threaten stability due to their inflexibility in adjusting the size of the buyer's payment to unforeseen, temporary revenue shocks that the buyer may face when dis-

[2] This reliance has been documented for several countries. Using representative trade data from Chile, Garcia-Marin et al. (2020) show that more than 95% of export transactions from Chile are taking place on cash-in-advance or open account payment terms. Antràs and Foley (2015) document a very comparable usage pattern for a large U.S. poultry exporter. Cuñat (2007) documents that direct lending between buyers and sellers is economically important not only in terms of trade flows but also in terms of the overall firm liabilities. He shows that for small and medium-sized firms from the United States and the United Kingdom, trade credit accounts for almost 50% of their short-term debt.A review over the reasons for the high prevalence of interfirm trade credit is available in Petersen and Rajan (1997), and our findings are complementary to them. They argue that sellers tend to have a financing cost advantage over traditional lenders due to a better ability to monitor buyers and to enforce credit repayment. In addition, trade credit gives sellers a device to price-discriminate, assure high product quality, and a tool to reduce transaction costs across repeat transactions with the same buyer.

[3] Important insights and a literature review on the role and interplay of formal and informal mechanisms in enforcing contracts can, for example, be found in Johnson et al. (2002) and Greif (2005).

tributing the product. In contrast, under open account, the payment size can be conditioned on final market outcomes, which decreases the relationship's vulnerability to such shocks. At the same time, since open account terms are less efficient in the selection of patient buyers, destination market institutions matter for the enforcement of buyer payment. Our model predicts that although relationship stability increases with the quality of institutions under open account terms, they have no effect under cash in advance.

From this screening outcome, it follows that the seller's choice between pre- and postshipment payment terms takes place in an *intertemporal trade-off between relationship stability and stage payoff growth*. While the strong screening efficiency of cash-in-advance terms has a destabilizing effect on relationships, at the same time, the implied learning advantage boosts the profitability of subsequent transactions under any payment type. We find that whenever trade partners are patient enough, this trade-off is sufficient to provide unique predictions on how the seller can choose payment terms optimally over the entire course of a trade relationship. When the seller finds it optimal to transition between payment terms over time this leads to the usage of open account terms and thereby to an increasing provision of trade credit as relationships become more established. In this context, the seller initially exploits the buyer-separating nature of the cash-in-advance terms and by subsequently switching to open account, he eliminates the risk of relationship breakdown due to buyer liquidity shocks in future transactions.

Decisive for the optimal usage pattern of payment terms is the seller's assessment of the buyer-type distribution, as well as the amount of information available about the buyer's revenue situation. For both—new and established relationships—the model predicts that the seller will more likely extend trade credit to the buyer the smaller his belief of getting matched to a patient buyer in future relationships. Although our transition predictions are confirmed by the external evidence summarized above, we show in an extension of the model that the documented patterns can only be rationalized when the seller is able to verify the buyer's revenue realizations from the distribution of products to final consumers. When this is not possible, the model predicts that requesting cash in advance from buyers is strictly preferable for sellers in established relationships. Our findings suggest that information transmission between trade partners plays a key role in explaining the financing patterns used in interfirm trade.

In a further model extension, we incorporate the possibility for the seller to obtain trade credit insurance from a competitive insurance market. When it comes to international trade, an important share of transactions with payment intermediation are backed by export credit insurances (cf. Van der Veer, 2015). In our model, the insurance takes over the risk of nonrepayment of the trade credit and generates value for the seller through the insurer's expertise in the screening of buyers. We show that the unique identification of the optimal payment terms remains possible when insurance is available. When revenue shocks are verifiable for the seller, the model continues to predict that the provision of seller trade credit increases over the course of relationships, which is consistent with the empirical findings of Antràs and Foley (2015).

Our analysis builds on several strands of literature where the first studies the financing terms of interfirm trade. It extends the interpretation of trade credit by Smith (1987), who first acknowledged its role as a screening device for sellers to elicit information about buyer characteristics. More generally, the article is related to a literature that sees credit rationing as a way to screen borrowers in markets with incomplete information (cf. Stiglitz and Weiss, 1981). Our model gives conditions under which, in equilibrium, trade credit is rationed either temporarily or permanently, where in the former case, this is due to screening considerations and in the latter case because financing trade is costly for the seller. While we focus on the self-financing of trade through the buyer and the seller, a complementary line of work investigates the rationales of firms to use trade credit instead of credit provided by external financial institutions.[4] Moreover, the article is connected to a literature on payment guarantees in international trade finance through our analysis of trade credit insurance. A concise summary of the most relevant work from this field was recently provided by Foley and Manova (2015).

Most closely related to our work is a small set of papers that studies the provision of trade credit in settings with repeated buyer–seller interaction. Their results are complementary to ours. The setup of our model features similarities to that of Antràs and Foley (2015), who investigate the impact of a financial crisis in a dynamic model of payment contract choice. Although they also study transitions between payment terms over time, their model does not incorporate that the information acquisition process of sellers differs fundamentally between pre- and postshipment terms, inducing structural differences in the optimal growth patterns of transaction volumes and per-period payoffs. Garcia-Marin et al. (2020) derive conditions under which the provision of trade credit increases in attractiveness to sellers as their relationships with buyers mature. Although in their model this prediction originates from a financing advantage for sellers under trade credit terms, it originates from an improved payment flexibility for buyers in our setting. Fuchs et al. (2022) conduct a field experiment in Uganda to show that restricted access to liquidity is a key impediment to the business of buyers in developing countries. Like us, they study in a model of self-enforcing relational contracts how the distribution of products in developing markets can be implemented optimally in a dynamic setting. Although in their work, the buyer's credit line is fixed over time, in our model the existence and size of the optimal trade credit line can vary with the age of trade relationships.[5] Our model variant with nonverifiable revenue shocks and truthtelling incentivization is inspired by Troya-Martinez (2017), who studies relational contracting between a buyer and a seller for the situation when trade credit is provided in every transaction.

Also beyond the context of our application, the article is related to the literature on self-enforcing relational contracts (Thomas and Worrall 1994, cf.; Baker et al., 2002; Levin, 2003)). Like us, Sobel (2006), MacLeod (2007), and Kvaloy and Olsen (2009) study the interaction of formal and self-enforcing contracts in repeated game models when legal contract enforcement is probabilistic. Closely related to us is Kvaloy and Olsen (2009), who investigate a situation of repeated investment in a principal–agent setting with endogenous verifiability of the contracting terms. Although in their setting verifiability is endogenized through the principal's investment in contract quality, in our model the relevance of verifiability itself is endogenized through payment contract choice. The article also adds to a growing literature on nonstationary relational contracts with adverse selection, in which contractual terms vary with relationship length. Although in our article, learning about the buyer induces transitions between payment contract types, previous work has studied nonstationarities in different contexts. Particularly closely related in terms of the modeling is the paper by Yang (2013), who investigates firm-internal wage dynamics when worker types are private information.[6]

[4] For example, Burkart and Ellingsen (2004) derive conditions under which trade and bank credit interact either as complements or substitutes with each other. Demir and Javorcik (2018) interpret trade credit provision as a margin of firm adjustment to competitive pressures arising from globalization. Engemann et al. (2014) understand trade credit as a quality signalling device that facilitates obtaining complementary bank credits.

[5] Beyond relationship aspects, the economic literature discusses further and complementary channels affecting the availability of trade credit to buyers. Common membership in business or ethnic networks tends to increase the willingness of sellers to provide trade credit (see Biggs et al., 2002; Fafchamps, 1997). Also, the level of competition among sellers is positively associated with the availability of trade credit to buyers (see Demir and Javorcik, 2018; Hyndman and Serio, 2010). In contrast to our work, these papers do not study the dynamic aspects of trade relationships.

[6] Besides, Chassang (2010) examines how agents with conflicting interests can develop successful cooperation when details about cooperation are not common knowledge. Halac (2012) studies optimal relational contracts when the value of a principal–agent relationship is not commonly known and, also, how information revelation affects the dynamics of the relationship. Board and Meyer-ter-Vehn (2015) analyze labor markets in which firms motivate their workers through relational contracts and study the effects of on-the-job search on employment contracts. Moreover, Defever et al. (2016) study buyer–supplier relationships in international trade in which new information can initiate a relational contract between parties.

A further strand of related literature investigates the microeconomic aspects of learning and trade dynamics, which, on the one side, considers applications to topics in international trade and, on the other side, contains papers of a purely contract-theoretic nature. Araujo et al. (2016) study how contract enforcement and export experience shape firm trade dynamics when information about buyers is incomplete. We share with their work the probabilistic approach to contract enforcement institutions. Across countries with different institutional qualities, the level and growth predictions for trade volumes in our model are analogous to theirs when the seller provides trade credit to the buyer throughout the trade relationship. Rauch and Watson (2003) study a matching problem between a buyer and a seller with one-sided incomplete information. They derive conditions under which starting a relationship with small trade volumes is preferable to starting with large transaction volumes from the very beginning. This pattern features a clear analogy to our model in which starting a relationship on open account terms corresponds to starting small, and on cash-in-advance terms to starting large. Extending beyond the scope of our analysis, Ghosh and Ray (1996) and Watson (1999, 2002) study agents' incentives to start small when information is incomplete on both sides of the market.[7]

The remainder of the article is organized as follows. In Section 2, we introduce the building blocks of our analysis and, in Section 3, we study supply relationships under cash-in-advance and open account payment terms when switches between payment terms are ruled out. Section 4 introduces this possibility and we investigate the seller's optimal usage of payment terms over the course of trade relationships. In Section 5, we extend our model and study trade credit insurance on the one side and the case of private revenue shocks on the other. Section 6 translates our most important model outcomes into empirically testable predictions. The last section concludes with a summary of our findings.

2. THE MODEL

The model considers the problem of a seller ("he") who markets a product through a buyer ("she") to final consumers. There exists a continuum of potential buyers with the ability to distribute the seller's product. The seller is a monopolist for the offered product and has constant marginal production costs $c > 0$. Selling $Q_t \geq 0$ units of the product to the final consumers in period $t + 1$ generates revenue $\mathcal{R}(Q_t, r_t) = r_t R(Q_t)$ to the buyer, where $R(Q_t) = Q_t^{1-\alpha}/(1-\alpha)$. The revenue function is increasing and concave in the trade volume Q_t, where $\alpha \in (0, 1)$ determines the shape of the revenue function.[8] Moreover, the revenue generated from the sales of Q_t is stochastic and depends on the realization of the revenue shifter $r_t \in \{r^l, r^h\}$, where $r^h > r^l > 0$. We assume that with an i.i.d. probability of $\gamma \in (0, 1)$ the revenue shifter takes value $r_t = r^h = 1$, and $r_t = r^l \to 0$ otherwise.[9] The realizations of the revenue shifter are public information to both, the buyer and the seller.[10]

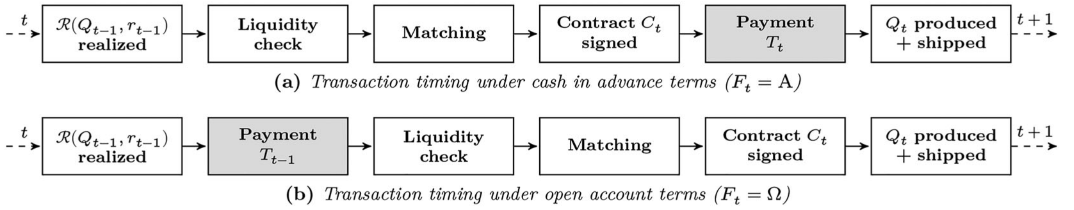
We model the buyer–seller relationship as a repeated game, where in every period, $t = 0, 1, 2, \ldots$ a transaction is performed. The seller can engage in only one partnership at the same time. In every period, the seller first decides either to continue the relationship with his current buyer or to re-match and start a new partnership. He then proposes a spot contract $C_t = \{Q_t, T_t, F_t\}$ to the buyer specifying a trade volume $Q_t \geq 0$, a transfer payment T_t from the

[7] Beyond the case of buyer–seller transactions, relationship building has also been analyzed in the context of different applications. For example, see Kranton (1996) and Halac (2014).

[8] Whether the concave shape of the revenue function stems from technology, preferences, or market structure is not important for the analysis below. Note that for this revenue function the price elasticity of demand is given as $\epsilon_{Q_t,p} = -1/\alpha$, and therefore final consumer demand is price-elastic. The elasticity can be calculated using the Amoroso-Robinson relation.

[9] In Appendix A.8, we discuss the effects of generalizing the revenue shock distribution to arbitrary levels of r^h and r^l. We avoid discussing the case where $r^l = 0$ as it implies uninformative complications in the open account scenario that are tedious to resolve.

[10] In Subsection 5.2, we discuss a model variant in which the realization of r_t is private information to the buyer.



(a) *Transaction timing under cash in advance terms ($F_t = \mathrm{A}$)*

(b) *Transaction timing under open account terms ($F_t = \Omega$)*

FIGURE 1

THE SPOT CONTRACT C_t DETERMINES THE TIMING OF THE STAGE GAME

buyer to the seller, and a payment contract, $F_t \in \mathcal{F} = \{A, \Omega\}$, that determines the point in time at which the transfer T_t is made. Depending on the payment contract, the seller receives the transfer either before he produces and ships the goods (cash-in-advance terms, $F_t = A$) or after the buyer has sold them (open account terms, $F_t = \Omega$). The contract C_t therefore determines the timing of the stage game, which we summarize graphically in Figure 1.

The timing of the transfer is payoff-relevant because shipment is time-consuming and players discount payoffs over time. Goods that are produced and shipped by the seller in period t can be sold to consumers only in the subsequent period $t + 1$. The corresponding discount factor of the seller is denoted by $\delta_S \in (0, 1)$. The buyer comes in one of two possible fixed types, $j \in \{M, B\}$. Either she is fully myopic, $j = M$, with discount factor $\delta_M = 0$ and associates positive value only to payoffs of the current period.[11] Alternatively, the buyer is patient, $j = B$, with discount factor $\delta_B \in (0, 1)$. Her type is the buyer's private information. The assumptions imply that by choosing open account terms, the seller extends *trade credit* to the buyer, whereas this is not the case under cash-in-advance terms. Whenever the seller decides to match with a new buyer, he draws her type from an i.i.d. two-point distribution, where with probability $\hat{\theta} \in (0, 1)$ the buyer is myopic, and patient otherwise. We denote the seller's belief that the buyer is myopic in period t by θ_t and assume that the seller holds the belief $\theta_0 = \hat{\theta}$ at the beginning of the initial transaction with a new buyer.

Access to sufficient credit and liquidity are key obstacles to the success of firms in international trade (cf. Harrison and McMillan, 2003; Manova, 2013). We introduce liquidity constraints into the model by assuming that the buyer goes bankrupt and leaves the market whenever her realized transaction payoff is negative. This means that the buyer remains liquid after a transaction under contract C_t if and only if the made transfer payment T_t is not larger than the revenue $R(Q_t, r_t)$ realized from sales to final consumers.[12] Formally,

$$\text{(LC}_\text{t}\text{)} \qquad \mathcal{R}(Q_t, r_t) - T_t \geq 0.$$

Note from the stage game timing described below that although the seller can rule out any risk of buyer bankruptcy under open account terms by conditioning transfers on revenue realizations, this is not possible under cash-in-advance terms where the transfer payment is made already before the revenue is realized.[13]

In every period, the contract C_t is enforced with an i.i.d. probability $\lambda \in (0, 1)$. We think of λ as being positively associated with the quality of contract enforcement institutions in the destination market, and to be public information for all market participants. In our application, for the buyer, it corresponds to the probability of not being able to deviate from making the prescribed transfer T_t and for the seller to the probability of being forced to produce

[11] In Appendix A.10, we study the case of a myopic type with positive discount factor, that is, $\delta_M \in (0, \delta_B)$.

[12] Alternatively, (LC_t) can be interpreted as a solvency constraint that the buyer must comply with in every period.

[13] Conditioning the transfer on the realization of r_t is possible if either the revenue realization is observable for the seller, or, if the buyer truthfully reports r_t in case the realized value is her private information. In the analysis, we focus on the public information case and summarize the results of the private information scenario in Subsection 5.2.

and ship as agreed upon. We assume that at the point where parties decide on whether or not to comply with the contractual terms, they are unaware of the institutional enforcement outcome. By using this probabilistic approach of contract enforcement, we follow an established literature that studies trade relationships in the presence of heterogeneous enforcement institutions (see Araujo and Ornelas, 2007; Araujo et al., 2016; Antràs and Foley, 2015).[14]

In the following, we summarize the stage game of period t, which is repeated ad infinitum. The strategy sets of both players contain the decision problems highlighted in italics below.

Stage game timing.

1. **Revenue realization**. The level of the revenue shifter r_{t-1} is realized and learned by the buyer and the seller. The product shipped in the previous period generates revenue $\mathcal{R}(Q_{t-1}, r_{t-1})$ to the buyer from the sale to final consumers.
2. **Payment (open account)**. The buyer *decides whether to make* transfer T_{t-1} to the seller. She finds an opportunity not to pay with probability $1-\lambda$. Upon nonpayment the match is permanently dissolved.
3. **Liquidity check**. The partnership remains active only if (LC_{t-1}) is fulfilled. The seller can *decide to forgive the buyer's transfer* and save her from bankruptcy. Otherwise, the match is permanently dissolved.
4. **Matching**. If unmatched, the seller *decides whether or not to start* a new partnership. If matched, the seller *decides whether to stay* with the current buyer *or to rematch*.
5. **Contracting**.
   - The seller *decides on the design* of a one-period spot contract $C_t = \{Q_t, T_t, F_t\}$ proposed to the buyer. The contract specifies a trade volume Q_t, a transfer T_t, and a payment contract F_t. If no proposal is made, the match is permanently dissolved.
   - The buyer *decides whether to accept* C_t. Upon rejection, the match is dissolved.
6. **Payment (cash in advance)**. The buyer *decides whether to make* transfer T_t to the seller. She finds an opportunity not to pay with probability $1-\lambda$. Upon nonpayment the match is permanently dissolved.
7. **Production and Shipment**. The seller *decides whether to produce and ship* Q_t as specified in the contract. Upon nonshipment the match is permanently dissolved.[15]

We define by $C = (C_t)_{t=0}^{\infty}$ the sequence of spot contracts offered by the seller over the course of the relationship. Moreover, we denote by $Q = (Q_t)_{t=0}^{\infty}$, $T = (T_t)_{t=0}^{\infty}$, and $F = (F_t)_{t=0}^{\infty}$ the corresponding sequences for trade volumes, transfer payments, and payment contracts, respectively. The proofs to all the results stated below can be found in the Appendix.

3. PAYMENT CONTRACTS IN ISOLATION

In this section, we study in isolation the two cases where the seller is restricted to choose either cash-in-advance or open account payment terms for all periods and rule out switches between payment terms over time. This corresponds to a situation in which the seller grants trade credit for either none or all transactions of a relationship. The possibility to vary trade credit provision over time is introduced in Section 4.

We consider the following *strategy profile*. The seller forms a new partnership whenever unmatched. He terminates an existing partnership if and only if the buyer defaults on the contract. In any period t, the seller chooses a trade volume Q_t and a transfer profile T_t that maxi-

[14] The enforcement concept assumes that the seller is not able to distinguish whether payment follows from the intrinsic motives of the (patient) buyer, or whether institutions enforce the (myopic) buyer's compliance with the contract. In Appendix A.9, we show that our qualitative findings remain valid when the seller can make this distinction.

[15] In principle, the seller's production and shipment decision is also subject to contract enforcement through institutions. However, since it does play a role in the subsequent analysis, we do not formally introduce an institutional parameter applicable in the seller's home market.

mize his current period expected payoffs.[16] The seller saves the buyer from bankruptcy whenever this gives him higher continuation payoffs. The buyer accepts the proposed contract C_t whenever participation promises an expected payoff that at least covers her outside option. The buyer's behavior with respect to an accepted contract is determined by her type and the realization of the revenue shifter. The myopic type deviates from any contract and not pay the transfer whenever possible. By assumption, the patient buyer is patient enough to never default from a contract as long as she does not suffer bankruptcy. Following Mailath and Samuelson (2006), we employ *sequential equilibrium* as equilibrium concept.[17]

In order to simplify the exposition of our results, we normalize the outside option of the buyer to zero. In the Online Appendix, we show that our results extend to the case where the buyer has a positive outside option.

3.1. *Cash-in-Advance Terms.* First, we study the case where the seller is restricted to write contracts on cash-in-advance terms (A-terms) only, that is, in any trade relationship $F = (A, \ldots)$.[18] Under this payment sequence, the seller never provides trade credit to the buyer. The participation constraint of a buyer of type $j \in \{M, B\}$ in period t is:

$$(\mathrm{PC}_{A}{}^{j,\,t}) \qquad \delta_j \mathcal{R}(Q_t, r_E) - T_t \geq 0,$$

where $r_E = \gamma r^h + (1-\gamma) r^l$ denotes the expected value of the revenue shifter. The constraint states that tomorrow's expected revenue $\mathcal{R}(Q_t, r_E)$ realized from the sale of today's shipment Q_t must be larger than the transfer T_t made to the seller before shipment. Because goods can be sold to final consumers only in the period following t, the revenue is multiplied by the buyer's discount factor δ_j. Observe that because $\delta_M = 0$, the myopic buyer's participation constraint, $(\mathrm{PC}^A_{M,t})$, cannot be fulfilled for any $T_t > 0$. Consequently, the myopic buyer will never accept any contract on A-terms and the seller offers a *separating contract* that only a patient buyer accepts. Hence, whenever a new trade relationship survives the initial transaction the seller can be certain to be matched with a patient buyer and his belief jumps from $\theta_0 = \hat{\theta}$ to $\theta_1 = 0$ and remains at this level for all further transactions with the same buyer.

Although a patient buyer accepts any contract on A-terms when $(\mathrm{PC}^A_{B,t})$ holds, she may suffer from liquidity problems in case (LC_t) is not satisfied. Anticipating the risk of buyer bankruptcy the seller has two options to set the transfer. On the one side, he can set $T_t^A = \delta_B R(Q_t, r_E)$ such that $(\mathrm{PC}^A_{B,t})$ binds. In this case, whenever the realized revenue is low the buyer is threatened by bankruptcy. Note that given revenue shocks are public information and the seller has learned from contract acceptance that the buyer is patient, he may find it profitable to save her from going bankrupt and repay T_t^A. In the main text, we present the model outcomes for the scenario where the buyer does not forgive the cash-in-advance payment as only this scenario turns out relevant for our main results in Section 4.[19] On the other side, the seller can set $T_t^{A,l} = R(Q_t, r^l) < T_t^A$ such that the liquidity constraint in the low revenue state binds, ensuring that the trade relationship with the patient buyer is maintained in all revenue

[16] Since we assume that only spot contracts are feasible and switching between payment contract types is ruled out here, the maximization of the current period expected payoffs implies that the ex ante expected payoffs are maximized simultaneously.

[17] The authors explain on pp. 158–59 that for adverse selection scenarios as we study them here, sequential equilibrium is appropriate to use. Intuitively, the strategy profile is *sequentially rational* "[...] if, after every personal history, player i is best responding to the behavior of the other players, given beliefs over the personal histories of the other players that are 'consistent' with the personal history that player i has observed" (Mailath and Samuelson, 2006, p. 147). In the context of our model, at any decision point a *personal history* consists of the observable behavior of both players that was previously generated within the same buyer–seller match.

[18] In the following, in the expressions for the sequence of payment contracts F, we drop the time index for notational convenience.

[19] In Appendix A.1, we show how the seller optimally decides between letting the illiquid buyer go bankrupt and not. It turns out that bankruptcy is preferable to the seller whenever the share of myopic buyers in the population, $\hat{\theta}$, is sufficiently small.

states. However, when the value of r^l is small (as we assume it here) setting $T_t^A = \delta_B R(Q_t, r_E)$ in all transactions is payoff-maximizing for the seller.[20] Hence, $T_t = T_t^A$.

Acknowledging this transfer strategy, the seller's trade volume choice solves the following maximization problem:

$$Q_t^A \equiv \arg\max_{Q_t} \pi_t^A = T_t^A - cQ_t, \tag{1}$$

that is, he sets Q_t to maximize the difference between received transfer payment and production costs. The optimal trade volume and the corresponding stage payoffs conditional on contract acceptance are given for all transactions on A-terms as:

$$Q^A = \left(\frac{\gamma\delta_B}{c}\right)^{\frac{1}{\alpha}}, \qquad \overline{\pi}^A \equiv \pi_t^A = Q^A \frac{c\alpha}{1-\alpha}.$$

Building on the observations above, the ex ante expected payoffs from conducting an infinite sequence of transactions on A-terms can be derived from solving the following dynamic programming problem. Denoting by V_t^i the payoff value function for payment contract type $i \in \mathcal{F}$ in period t we have:

$$\begin{aligned} V_0^A &= (1-\theta_0)\overline{\pi}^A + \delta_S\big[\gamma(1-\theta_0)V_1^A + (1-\gamma(1-\theta_0))V_0^A\big], \\ V_1^A &= \overline{\pi}^A + \delta_S\big[\gamma V_1^A + (1-\gamma)V_0^A\big]. \end{aligned} \tag{2}$$

Note that a trade relationship with the same patient buyer is productive and continued only if this buyer does not go bankrupt in the respective transaction, that is, with probability γ. Otherwise, a trade relationship with a new buyer is started. Solving the programming problem for V_0^A gives the seller's ex ante expected payoffs under A-terms, Π^A. They are:

$$\Pi^A = \frac{(1-\theta_0)\overline{\pi}^A}{(1-\delta_S)(1-\gamma\theta_0\delta_S)}.$$

Under A-terms, the buyer has to make the transfer before the seller's production and shipment decision. Consequently, the seller may have an incentive to deviate and not produce the output, seize the transfer, and rematch to a new buyer in the next period. To avoid this deviation, the following incentive constraint of the seller has to hold:

$$-cQ^A + \delta_S V_1^A \geq \delta_S V_0^A. \tag{IC$_S$}$$

Lemma 1 provides parameter conditions to ensure that (IC$_S$) holds and guarantees equilibrium existence.[21]

LEMMA 1. *Suppose that consumers' price elasticity of demand is sufficiently constrained, that is, $\alpha > \tilde{\alpha} \in (0,1)$. Then there exists an equilibrium of the repeated game where the seller's payoff is Π^A—his maximum ex ante payoff under cash-in-advance terms—for all $\delta_S \geq \tilde{\delta}_S \in (0,1)$.*

Some remarks on Lemma 1 are in order. For an equilibrium of the repeated game to exist, the stage payoffs generated from the sale of Q^A units of the product must be large enough,

[20] For further details and a discussion of the more general case with $r^l \in (0, r^h)$, see Appendix A.8.

[21] In order to improve readability, the explicit statement and the derivations of all parameter thresholds of the article are omitted in the main text and can be found in Appendix A.1. Thresholds $\tilde{\delta}_S$ and $\tilde{\alpha}$ are defined in Equations (A.2) and (A.3), respectively.

that is, larger than the threshold level implied by $\tilde{\alpha}$ and satisfied for all $\alpha > \tilde{\alpha}$. Otherwise, a deviation by the seller cannot be ruled out since the transaction's profit margin becomes negligible and the deviation ensures the seller the full transfer at zero cost. Stated differently, the lower bound on α implies that final consumer demand must not be too price-elastic, that is, $|\epsilon_{Q^A,p}| < 1/\tilde{\alpha}$ must hold.[22] Provided that $\alpha > \tilde{\alpha}$ holds, there exist repeated game equilibria rationalizing the behavior prescribed by the strategy profile if the seller is sufficiently patient, as implied by the minimum discount factor $\tilde{\delta}_S$. Proposition 1 summarizes our key findings on the cash-in-advance equilibrium.

PROPOSITION 1. *Suppose that payment is only possible on A-terms and Lemma 1 holds. Then the seller proposes a separating contract C_t that only patient buyers accept. In every period, the seller produces and ships the payoff-maximizing trade volume Q^A. The expected stage payoffs increase from $(1-\theta_0)\overline{\pi}^A$ to $\overline{\pi}^A$ after the first transaction and stay at this level for the remainder of the trade relationship. The seller's ex ante expected payoffs are Π^A.*

There are several points noteworthy about this equilibrium. First, profit maximization under cash-in-advance terms necessarily separates buyer types as these are very demanding for the buyer. This is demonstrated by the fact that A-terms exclude myopic buyers from cooperation altogether. For the seller, cash-in-advance terms have the advantage of excluding any risk of nonpayment and imply that the time-invariant trade volume Q^A is optimal beginning with the first transaction. Moreover, all information about the buyer's type is acquired immediately with the acceptance or rejection of the initial contract C_0. The stability of the trade relationship with a patient buyer depends on the realizations of the revenue level and is maintained as long as revenue realizations are high (i.e., $r_t = 1$).

Let us stress that the separation outcome under A-terms does not depend on our assumption of a fully myopic buyer. In Appendix A.10, we show that for any $\delta_M \in [0, \delta_B)$ any contract that is incentive compatible and payoff-maximizing for the seller is separating and as such only accepted by the more patient buyer. Note also, that optimal contract design under A-terms does not depend on whether the revenue shock is realized publicly or privately to the buyer. The reason is that under A-terms, the buyer's contract acceptance as well as her transfer payment decision take place before the revenue shifter is realized (for details, see Subsection 5.2). This implies a contrast to the situation under Ω-terms, which we study in the following section.

3.2. *Open Account Terms.* Let us now turn to the case where the seller is restricted to write contracts on open account terms (Ω-terms) only, that is, in any trade relationship $F = (\Omega, \ldots)$. This case implies that trade credit is offered to the buyer in all transactions.

In contrast to A-terms discussed above, under Ω-terms the buyer can make the transfer specific to the size of the realized revenue since payment is conducted subsequently. We denote by $T_t^{\Omega,h}$ and $T_t^{\Omega,l}$ the transfer that a contract assigns to a high respectively low revenue realization and denote by $ET_t^{\Omega} = \gamma T_t^{\Omega,h} + (1-\gamma)T_t^{\Omega,l}$ the expected transfer payment.[23] Based on the strategy profile, we can write the participation constraints of the two buyer types for a period t contract as:

$$(\mathrm{PC}_{B,t}{}^{\Omega}) \qquad \gamma R(Q_t) - ET_t^{\Omega} \geq 0,$$

$$(\mathrm{PC}_{M,t}{}^{\Omega}) \qquad \gamma R(Q_t) - \lambda ET_t^{\Omega} \geq 0,$$

[22] A more extensive discussion on the relevance of this parameter constraint can be found after the presentation of our main results in Proposition 3.

[23] Alternatively, the seller can offer a "flat" contract to the buyer specifying a transfer level that is independent of the revenue realization. Although this approach is payoff-maximizing when revenue realizations are private information to the buyer, it is payoff-dominated in the public information case. For a discussion, see Subsection 5.2.

where ($PC_{B,t}^{\Omega}$) is the participation constraint of the patient buyer and ($PC_{M,t}^{\Omega}$) that of the myopic buyer. A comparison reveals that under Ω-terms it is impossible to construct a separating contract that would guarantee to select only patient buyers. The reasons are twofold. First, myopic buyers anticipate to transfer a share of the generated revenue only if the contract is enforced. This happens with probability λ and makes their PC more lenient compared to that of the patient type. Second, discounting does not affect the buyer's participation decision since both, revenue realization and payment for a period t contract happen in period $t+1$. Consequently, any feasible transaction on open account terms involves a *pooling contract*.

Suppose now that buyers behave as prescribed by the strategy profile and consider the seller's belief on the buyer's type. If the risk of buyer bankruptcy is ruled out (which the seller does by setting the state-contingent transfers accordingly, see below), then patient buyers will never deviate and myopic buyers do so whenever possible (i.e., they do not make the transfer when contracts are not enforced). Hence, if no deviation occurs up to the tth transaction with the same buyer, the seller's belief of facing a myopic type in period t is given by Bayes' rule as:[24]

$$\theta_t^{\Omega} = \frac{\hat{\theta}\lambda^t}{1-\hat{\theta}(1-\lambda^t)}. \tag{3}$$

Using Equation (3), the payment probability in period t of a relationship can be written as $\Lambda(t, \hat{\theta}, \lambda) = 1 - \theta_t^{\Omega}(1-\lambda) = [1-\hat{\theta}(1-\lambda^{t+1})]/[1-\hat{\theta}(1-\lambda^t)] \equiv \Lambda_t$. Note that $\lim_{t\to\infty}\theta_t^{\Omega} = 0$ and $\lim_{t\to\infty}\Lambda_t = 1$, that is, as the relationship with a buyer continues, the seller's belief of being matched with a myopic buyer converges to zero while the associated payment probability converges to one. In the following, we refer to this limiting situation as the *full information limit*.

Equipped with this notion of belief formation and updating, the seller's expected stage payoff function takes the following form:

$$\pi_t^{\Omega} = \delta_S\Lambda_t\Big[\gamma T_t^{\Omega,h} + (1-\gamma)T_t^{\Omega,l}\Big] - cQ_t. \tag{4}$$

Although the seller has to bear the costs of production cQ_t already in period t, he receives the expected transfer $\Lambda_t ET_t^{\Omega}$ only in the following period, which is therefore discounted by δ_S.

Under open account, when deciding on the revenue-contingent transfers $T_t^{\Omega,h}$ and $T_t^{\Omega,l}$, the seller faces two challenges. First, he must ensure that the (patient) buyer's liquidity constraint is fulfilled for both possible revenue realizations. Formally, the following constraints must hold:

$$\mathcal{R}(Q_t, r^l) - T_t^{\Omega,l} \geq 0, \tag{LC_t^l}$$

$$\mathcal{R}(Q_t, r^h) - T_t^{\Omega,h} \geq 0. \tag{LC_t^h}$$

Since a buyer can foresee her bankruptcy when making the transfer and the respective liquidity constraint does not hold, she will instead keep the revenue for herself and accept that the relationship is discontinued. This also implies that it is optimal for the seller to offer a contract with revenue-contingent transfers.

[24] In Appendix A.9, we discuss the alternative scenario where the seller can directly observe the buyer's intention of not paying, which makes court usage a decision variable for the seller. In this case, the seller's belief updating process under Ω-terms is identical to A-terms. Still, our central result prevails that a stage contract on Ω-terms cannot separate buyer types and, as a consequence, we see trade volume growth over the course of transactions. Moreover, we are able to account for the observations of Macaulay (1963), who documents that business relationships often die once courts are used to enforce contract terms.

Second, it is not enough to merely account for the participation and liquidity constraints to guarantee that the patient buyer does not deviate. In addition, she must be incentivized by the expected payoffs of future transactions to pay the transfer instead of seizing the period's entire revenue and accept being rematched. In order to maintain tractability, we assume that buyers are unaware of the seller's belief formation process and expect the terms of future contracts C_k, with $k > t$, to be identical to those of the contract signed in period t. This implies that the buyer conditions her behavior on the same information set under both, A- and Ω-terms.[25] Formally, the revenue state-contingent incentive constraints for a buyer of type $j \in \{M, B\}$ are:

$$(\mathrm{IC}_{j,t}{}^{\Omega,l}) \qquad -T_t^{\Omega,l} + \tfrac{\delta_j}{1-\delta_j}[\gamma R(Q_t) - ET_t^{\Omega}] \geq 0,$$

$$(\mathrm{IC}_{j,t}{}^{\Omega,h}) \qquad -T_t^{\Omega,h} + \tfrac{\delta_j}{1-\delta_j}[\gamma R(Q_t) - ET_t^{\Omega}] \geq 0.$$

Note that the incentive constraints are never fulfilled for the myopic buyer for any $T_t > 0$ and she will deviate whenever contracts are not enforced. The following Lemma 2 derives conditions that ensure buyers to behave according to the strategy profile, while maximizing the seller's stage game payoffs.

LEMMA 2. *Under Ω-terms, the seller sets transfers $T_t^{\Omega,l} = \mathcal{R}(Q_t.r^l) \approx 0$ and $T_t^{\Omega,h} = \delta_B\gamma/(1 - \delta_B(1-\gamma))R(Q_t)$. Thereby, he rules out the buyer bankruptcy risk, makes the patient buyer indifferent between paying and not paying the agreed upon transfer in any revenue state, and maximizes his own payoffs.*

Acknowledging the results of Lemma 2, the seller chooses the trade volume in period t by maximizing the following variant of (4):

$$Q_t^{\Omega} \equiv \arg\max_{Q_t} \delta_S \Lambda_t \mathcal{T} R(Q_t) - cQ_t, \qquad \text{where} \quad \mathcal{T} = \frac{\delta_B \gamma^2}{1 - \delta_B(1-\gamma)}.$$

The optimal trade volume Q_t^{Ω} and the corresponding stage game payoff π_t^{Ω} in the tth transaction with a buyer on open account terms can be calculated as:

$$Q_t^{\Omega} = \left(\frac{\delta_S \mathcal{T} \Lambda_t}{c}\right)^{\frac{1}{\alpha}}, \qquad \pi_t^{\Omega} = Q_t^{\Omega} \frac{c\alpha}{1-\alpha}.$$

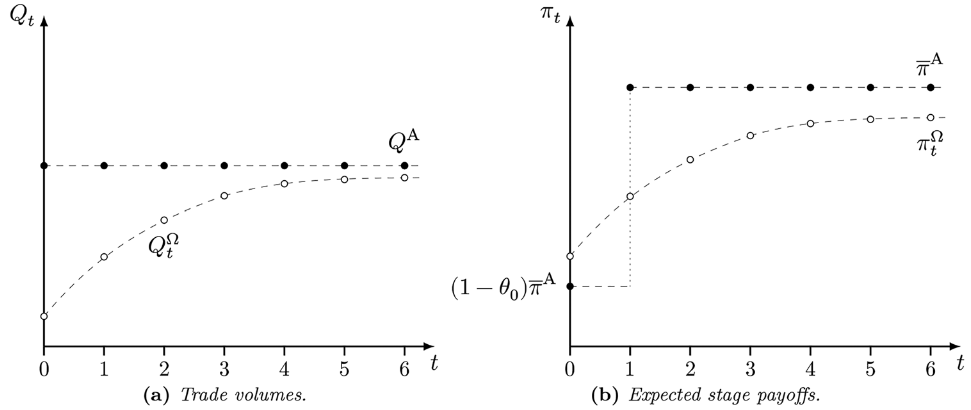
We define the trade volume and stage payoffs at the full information limit as $Q^{\Omega} \equiv \lim_{t\to\infty} Q_t^{\Omega} = (\delta_S \mathcal{T}/c)^{1/\alpha}$ and $\overline{\pi}^{\Omega} \equiv \lim_{t\to\infty} \pi_t^{\Omega} = Q^{\Omega} c\alpha/(1-\alpha)$, respectively.[26]

The seller's ex ante expected payoff from a trade relationship on open account terms, Π^{Ω}, can be obtained from solving the following dynamic programming problem for V_0^{Ω}:

$$(5) \qquad \forall t \geq 0: \quad V_t^{\Omega} = \pi_t^{\Omega} + \delta_S\big(\Lambda_t V_{t+1}^{\Omega} + (1-\Lambda_t)V_0^{\Omega}\big).$$

[25] The assumption also implies, that the nonstationarity of relational contracts comes into the analysis exclusively through the belief formation on the seller side. This restriction is in line with the most directly related literature in the field of international trade, see Antràs and Foley (2015) and Araujo et al. (2016).

[26] For later use, note that the expected stage payoffs under belief θ_t^{Ω} can be rewritten as an expression that is proportional to the stage payoffs at the full information limit, that is, $\pi_t^{\Omega} = \Lambda_t^{\frac{1}{\alpha}} \overline{\pi}^{\Omega}$.



(a) *Trade volumes.* **(b)** *Expected stage payoffs.*

FIGURE 2

TRADE VOLUMES AND EXPECTED STAGE PAYOFFS (AT THE CONTRACTING STAGE)

In Appendix A.1, we derive the following solution to this problem:

$$\Pi^{\Omega} = \frac{1-\delta_S\lambda}{1-\delta_S\lambda-\delta_S\theta_0(1-\lambda)}\overline{\pi}^{\Omega}\sum_{t=0}^{\infty}\delta_S^t\Lambda_t^{\frac{1}{\alpha}}(1-\theta_0(1-\lambda^t)). \tag{6}$$

We summarize our findings on the open account equilibrium in Proposition 2.

PROPOSITION 2. *Suppose that payments are only possible on Ω-terms. Then, the seller proposes a pooling contract to the buyer and updates his belief as prescribed by θ_t^{Ω} as the relationship proceeds. Based on this belief, the trade volume Q_t^{Ω} (the expected stage payoffs π_t^{Ω}) increases gradually with the age of the relationship and converges to the full information level Q^{Ω} ($\overline{\pi}^{\Omega}$). The ex ante expected payoffs of the seller are Π^{Ω}.*

3.3. *Discussion.* A comparison of the results of Subsections 3.1 and 3.2 reveals important differences between cash-in-advance and open account payment terms. On the one side, they can be summarized as features related to the *learning process* about the buyer, and to the *risks of relationship breakdown* on the other side.

First, consider the learning process about the buyer in a new relationship. Under cash-in-advance terms, the seller optimally offers a separating stage contract that immediately reveals the buyer's type. In contrast, immediate separation is not possible under Ω-terms where the payoff-maximizing stage contract pools both types. In this case, type information is acquired only gradually over time through the Bayesian updating process. Type separation under A-terms translates into a comparably high trade volume Q^A from the first transaction, whereas trade volumes under Ω-terms grow over time and converge to the belief-free level Q^{Ω} as the relationship matures. These patterns have immediate repercussions on the evolution of stage payoffs. Under A-terms, the expected stage payoffs jump from $(1-\theta_0)\overline{\pi}^A$ to $\overline{\pi}^A$ immediately and permanently after the first successful transaction with the same buyer. In contrast, under Ω-terms, they increase at a strictly slower rate up to $\overline{\pi}^{\Omega}$—the payoffs at the full information limit. Note that these results do not rely on the assumption of a fully myopic buyer. In Appendix A.10, we show that as long as the discount factors of both types differ sufficiently, these results prevail.

Figure 2 illustrates the evolution of trade volumes and the seller's expected stage payoffs over the course of a trade relationship. It shows the payoff expectation as formed at the beginning of the contracting stage in the tth transaction with the same buyer. Note that $Q_t^{\Omega} < Q^A$ and $\pi_t^{\Omega} < \overline{\pi}^A$ also for $t \to \infty$ due to the timing of the transfer payment.[27]

Second, let us compare the risks of transaction failure across payment terms. Under the considered strategy profile, transaction failure directly corresponds to the breakdown of the trade relationship with a buyer. Whereas under A-terms, transaction failure is triggered by buyer characteristics (i.e., her type and/or liquidity status), under Ω-terms the institutional environment is decisive. Under the latter, a transaction can be unsuccessful only if contracts are not enforced, which induces transfer *nonpayment* in a match with a myopic buyer. In contrast, A-terms do not involve any payment risk for the seller since the transfer is made already before production and shipment. However, the transaction can still be unsuccessful as A-terms cause *nonparticipation* of the myopic buyer. Moreover, although low revenue realizations can cause relationship breakdown under A-terms due to buyer illiquidity, this never occurs under Ω-terms. Here, the optimal transfer conditions on the size of the realized revenue, which eliminates liquidity concerns.

Ex ante to contracting, the probability of transaction failure in period t for both payment types is given as $P_t^A = 1 - \gamma(1 - \theta_t)$ and $P_t^{\Omega} = \theta_t(1 - \lambda)$, respectively. Evidently, $P_t^{\Omega} < P_t^A$ holds and the seller can benefit from a smaller failure risk under Ω-terms the stronger contracting institutions are. Consequently, when deciding whether or not to provide trade credit to a new buyer, the seller has to weigh the relationship stability-enhancing advantages of trade credit with the associated, comparably slow learning process about the buyer and the corresponding moderate growth of stage payoffs on the equilibrium path. In the following section, we study how the seller can manage this *trade-off between relationship stability and stage payoff growth* efficiently.

4. DYNAMICALLY OPTIMAL PAYMENT CONTRACTS

4.1. *Main Results.* We now study the seller's optimal choice of payment contracts when he can separately decide between A- and Ω-terms—and hence about the provision of trade credit—in every period of the repeated game, that is, $F_t \in \mathcal{F}$ for all $t \geq 0$. This will give us an understanding of how the intertemporal trade-off identified in Section 3 determines optimal payment contract choice in the dynamic context.

DEFINITION 1. The sequence F that maximizes the seller's ex ante expected payoffs from the trade relationship is called the *dynamically optimal sequence of payment contracts* (DOSPC).

Determining the DOSPC from a direct comparison of all available sequences is impossible since this set contains infinitely many elements as a consequence of the infinite time horizon of the game. However, simple parameter refinements allow us to endogenously reduce the set of possibly optimal sequences to three elements.

PROPOSITION 3. *For all parameterizations of the model satisfying the constraints $\alpha > \underline{\alpha} \in (0, 1)$ and $\delta_B > \underline{\delta}_B \in (0, 1)$, there exists a unique $\underline{\delta}_S \in (0, 1)$ such that for all $\delta_S > \underline{\delta}_S$ we have $F \in \{(A, \ldots), (\Omega, \ldots), (A, \Omega, \Omega, \ldots)\} \equiv \mathcal{F}^D$ as the DOSPC.*[28]

The parameter constraints in Proposition 3 address three distinct incentive problems. The first addresses the seller's motivation to switch between payment terms over the course of a trade relationship. We show that in the initial transaction of a new relationship both, A-

[27] Moreover, note that $\lim_{\delta_B \to 1} \lim_{\delta_S \to 1} Q^{\Omega} = Q^A$ and $\lim_{\delta_B \to 1} \lim_{\delta_S \to 1} \overline{\pi}^{\Omega} = \overline{\pi}^A$, that is, the trade volumes and stage payoffs at the full information limit under A- and Ω-terms converge as both, the seller and the patient buyer become very patient. Figure 2b depicts the situation where at $t = 0$ the expected stage payoff is larger under Ω- than under A-terms. The reverse scenario can also occur in equilibrium.

[28] The parameter thresholds $\underline{\alpha}$, $\underline{\delta}_S$, and $\underline{\delta}_B$ are defined in the Appendix in equations (A.9) and (A.10).

and Ω-terms, can be optimal. Hence, switches away from either payment mode must be considered. On the one side, observe that any relationship that starts on A-terms reaches the full information limit after the first successful transaction. Consequently, either the sequence $(A, \ldots)$ or $(A, \Omega, \Omega, \ldots)$ must be optimal in this case. On the other side, whenever the trade relationship starts on Ω-terms, switches to A-terms in later periods are never optimal. Intuitively, this is the case because the informational gains under Ω-terms relative to those under A-terms are smallest in the initial transaction. Hence, whenever Ω-terms payoff-dominate in the initial transaction for the seller, they also do so in later periods. Note that a necessary requirement for any sequence other than $(A, \ldots)$ to be optimal is that the seller is sufficiently patient, as payment under Ω-terms occurs only in the following period.

A second set of incentive constraints relates to the nonshipment deviation of the seller under A-terms. Although Lemma 1 rules out nonshipment for sequence $F = (A, \ldots)$ in Proposition 3, we derive additional, equivalent conditions for $F = (A, \Omega, \Omega, \ldots)$. The corresponding lower bound on parameter α corresponds to an upper bound on the product's price elasticity of demand (for details, see Subsection 3.1). It can be interpreted as a restriction on the set of export markets for which our model provides unique predictions. In an empirical context, this speaks to the findings by Imbs and Mejean (2015), who show that trade price elasticities are highly heterogeneous across sectors in OECD countries.[29] Incentivizing product shipment in the initial transaction for sequence $(A, \Omega, \Omega, \ldots)$ additionally requires sufficient buyer patience ($\delta_B > \underline{\delta}_B$) since the seller's continuation payoff under Ω-terms depends positively on the patient buyer's discount factor.

A final set of constraints deals with the seller's incentive to save the patient buyer from bankruptcy when the latter is hit by a liquidity shock under A-terms. The results differ between the sequences $(A, \ldots)$ and $(A, \Omega, \Omega, \ldots)$. We find, that with the possibility to switch payment contracts over time it is never optimal for the seller to save the buyer from bankruptcy when sequence $(A, \ldots)$ is the DOSPC. In contrast, when the seller chooses sequence $(A, \Omega, \Omega, \ldots)$ either option can be optimal in equilibrium (see the discussion of Corollary 1).

Summing up, Proposition 3 uncovers that when the trade partners are patient enough and when final consumer demand is sufficiently price-inelastic the trade-off between relationship stability and information acquisition outlined in Subsection 3.3 is sufficient to reduce the set of feasible DOSPCs to $\mathcal{F}^D$. The following Corollary 1 goes one step further by showing how the seller can resolve the trade-off efficiently and identifies unique conditions under which either sequence is dynamically optimal.

Corollary 1.

(a) Under the conditions of Proposition 3 there exists a unique belief threshold $\underline{\theta}_0 \in (0, 1)$ *such that the DOSPC is* $F = (A, \ldots)$ *if* $\theta_0 < \underline{\theta}_0$. *For both sequences* $F \in \{(A, \Omega, \Omega, \ldots), (\Omega, \ldots)\}$, *there exist parameter values* $\theta_0 \in (\underline{\theta}_0, 1)$ *under which either sequence is optimal. For* $\theta_0 \to 1$, *the DOSPC is* $F = (\Omega, \ldots)$.

(b) When in addition $\alpha > \overline{\alpha} \in [\underline{\alpha}, 1)$ *holds, there exists a unique* $\overline{\theta}_0$ *with* $0 < \underline{\theta}_0 < \overline{\theta}_0 < 1$ *such that the DOSPC is determined as follows:*

- $F = (A, \ldots)$ *if* $\theta_0 < \underline{\theta}_0$,
- $F = (A, \Omega, \Omega, \ldots)$ *if* $\theta_0 \in (\underline{\theta}_0, \overline{\theta}_0)$,
- $F = (\Omega \ldots)$ *if* $\theta_0 > \overline{\theta}_0$.

Figure 3 provides a graphical summary of the results in Corollary 1(b).[30] It shows the

[29] Using data from 16 OECD countries, Imbs and Mejean (2015) estimate trade elasticities for 56 ISIC sectors for which they document price elasticities ranging from −2.2 to −29. In the context of their data, our results imply that although the predictive power of Proposition 3 is high for relatively price-inelastic sectors such as the "dairy products" industry, it is not as strong for sectors with high demand elasticity such as the "crude petroleum" industry. For further details, see subsection II.B and figure 2 of their paper.

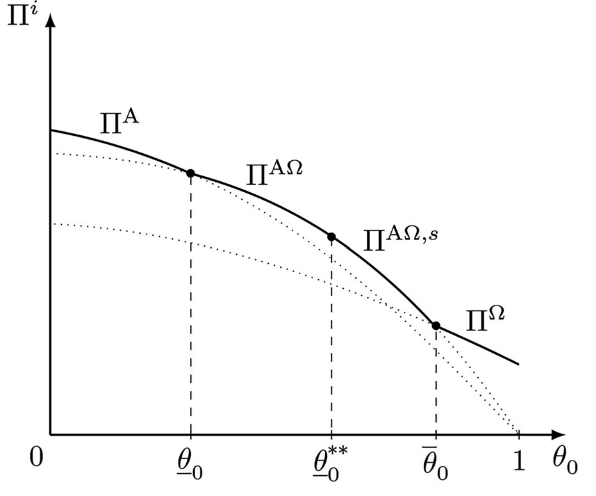


FIGURE 3

EX ANTE EXPECTED PAYOFF FUNCTIONS UNDER THE CONDITIONS OF COROLLARY 1(B)

seller's ex ante expected payoffs resulting from any of the payment sequences in $\mathcal{F}^D$ as a function of the seller's initial belief that the buyer is myopic, θ_0. For given $\theta_0 \in (0, 1)$, the seller chooses the payment sequence, which gives him the highest expected payoffs (as indicated by the solid line segments). Note that $\Pi^{A\Omega}$ (respectively, $\Pi^{A\Omega,s}$) denotes the seller's payoff under sequence $(A, \Omega, \Omega, \ldots)$ when letting (respectively, not letting) the buyer go bankrupt after a liquidity shock in the initial transaction. We find that for both—new and established relationships that survive the initial transaction—Ω-terms and therefore the provision of seller trade credit is more likely optimal the higher belief θ_0, and correspondingly, the larger the population share of myopic buyers. We elaborate on the reasons for this pattern in the following.

Consider first the situation in a newly matched buyer–seller relationship. Given $\mathcal{F}^D$, the design of C_0 determines how the intertemporal trade-off between relationship stability and payoff growth is resolved optimally. Corollary 1 shows that the mitigation of relationship breakdown risks is more likely prioritized to acquiring new information about the buyer, the higher the initial belief θ_0 of drawing a myopic buyer. If θ_0 is large, then conducting an initial transaction on A-terms is unlikely successful since only a small share of patient buyers will accept such a contract. This reduces the ex ante expected payoffs associated with sequences that include A-terms and makes their optimality less likely. When the seller's belief is moderate and sequence $(A, \Omega, \Omega, \ldots)$ is optimal, the trade-off drives further microadjustments on how this sequence is implemented by the seller. Although for relatively low beliefs, $\theta_0 \in (\underline{\theta}_0, \underline{\theta}_0^{**})$, letting the buyer go bankrupt after a low-revenue shock in the initial transaction is optimal for the seller, for higher values, $\theta_0 \in (\underline{\theta}_0^{**}, \overline{\theta}_0)$, he prefers making an ex post transfer to save the buyer from bankruptcy.

In order to understand the rationale for varying payment terms over time, we can focus on the situation where A-terms are used initially. Although the expected stage payoffs in any subsequent transaction are larger under A-terms (i.e., $\overline{\pi}^A > \overline{\pi}^\Omega$), continuing the relationship on A-terms can retain the risk of loosing a certainly patient buyer due to liquidity problems. Corollary 1 predicts that switching to Ω-terms after the initial transaction is preferable to obtaining high stage payoffs under full information when the likelihood of finding another pa-

[30] The additional constraint on α in Corollary 1(b) ensures the concavity of Π^Ω in θ_0. Due to the complex series expression of Π^Ω—see Equation (6)—we rely on a combination of element-wise analytical comparative statics and a numerical simulation for the payoff series as a whole to proof this. Requiring $\alpha > \overline{\alpha}$ ensures the uniqueness of $\overline{\theta}_0$. Note that there also exist model parameterizations for which $\overline{\theta}_0 < \underline{\theta}_0$, implying some $F \in \{(A, \ldots), (\Omega, \ldots)\}$ as DOSPC.

tient buyer is low (i.e., when $\theta_0 > \underline{\theta}_0$). In this situation, the seller rather accepts lower stage payoffs and offers trade credit instead of risking to lose the patient buyer. Conversely, when the probability of finding a patient buyer upon relationship breakdown is high (i.e., when $\theta_0 < \underline{\theta}_0$), the seller does not find it threatful to lose his current buyer and continues business on A-terms throughout.

4.2. *Discussion.* Our model proposes a novel, dynamic mechanism to explain the substantial provision of trade credit by sellers and its availability to buyers engaged in international trade. It predicts that sellers are more prone to provide trade credit to their business partners, the harder it is for them to find a reliable, patient buyer in the destination market and the more established the trade relationship with a particular buyer becomes. The reason is that compared to A-terms, under Ω-terms the stability of the trade relationships is not threatened by potential buyer liquidity problems, which is particularly valuable when finding a reliable buyer is difficult. Stated differently, providing trade credit allows the seller to insure the trade relationship against breakdown due to unfavorable changes in buyer revenues. Whenever the seller increases trade credit provision over time this originates from a learning effect about the buyer's type and eliminates the costs of illiquidity-induced relationship breakdown.

The analysis shows that payment types can be interpreted as distinct *contract enforcement technologies*. Although under Ω-terms enforcement is ensured by publicly available institutions, under A-terms it is ensured privately through the design of the contract terms, which are only acceptable to reliable, patient buyers. For new trade relationships, our theory predicts that whenever the share of patient buyers is small, then relying entirely on buyer selection to ensure payment (i.e., choosing A-terms for the initial transaction) is inefficient as any relationship with a myopic buyer fails immediately. In contrast, the "softer" screening under Ω-terms also allows these buyers to take up possibly productive trade relationships, which has a stabilizing effect on the expected payoff stream of the seller. Overall, we show that acknowledging the screening properties of payment contracts allows to derive unambiguous recommendations on how a seller can efficiently resolve the corresponding trade-off between relationship stability and stage payoff growth.

5. MODEL EXTENSIONS

In the following, we introduce and discuss the results of key extensions to our model. We focus on an intuitive summary of results and relegate the detailed analysis and formal derivations to the Online Appendix.

5.1. *Trade Credit Insurance.* The provision of trade finance through banks and insurance firms is an important, additional driver for the growth of firms' trade volumes (cf. Amiti and Weinstein, 2011). In the following, we discuss how the availability of trade credit insurance impacts dynamically optimal payment contract choice. In our model, this means that instead of taking the risk of buyer nonpayment in an open account transaction himself, the seller can rule it out by employing trade credit insurance ($F_t = I$).

Following Niepmann and Schmidt-Eisenlohr (2017), we assume that the insurance is available from a perfectly competitive insurance market, in which the cost of insurance depends positively on the size of the insured transfer and inversely on the payment probability. The insurer creates value for the seller by engaging in buyer screening itself, thereby reducing the share of myopic buyers in the population and—vice versa—increasing the probability of buyer payment.[31] We augment the above strategy profile by assuming that the trade relationship fails whenever the insurance has to cover for buyer nonpayment.

[31] This assumption is endorsed by the fact that trade credit insurers such as Euler Hermes and AIG advertise their insurance services with their expertise in monitoring the reliability of transaction counterparts.

Optimal spot contract design with insurance is largely identical when compared to the open account scenario discussed in Subsection 3.2. The results of Lemma 2 directly apply and merely trade volumes are adjusted upwards, which is a benefit generated from the insurer's screening activity. In the dynamic context, the seller has available one additional payment term option in every transaction, such that $F_t \in \mathcal{F}^+ \equiv \{A, \Omega, I\}$. We obtain the following result on how the availability of insurance affects the set of feasible DOSPCs.

PROPOSITION 4. *Let $F_t \in \mathcal{F}^+$ for all $t \geq 0$. Under the conditions of Proposition 3, it holds that some $F \in \mathcal{F}^D \cup (I, \Omega, \Omega, \dots) \equiv \mathcal{F}^{D+}$ is the DOSPC.*

Proposition 4 establishes that $F = (I, \Omega, \Omega, \dots)$ is the only additional sequence that can become dynamically optimal. This is because, first, I-terms are payoff-dominated by Ω-terms at the full information limit and after the initial play of I-terms and, second, the informational benefit from insurer screening is largest in the initial period. Finally, we show that whenever the insurer is sufficiently cost- and/or screening-efficient, there exist model configurations in which using the payment sequence $F = (I, \Omega, \Omega, \dots)$ is in fact dynamically optimal.

5.2. *Private Observability of Revenue Shocks.* Next, we summarize our results for the scenario where the realized level of revenue, r_t, is observed privately by the buyer. We allow the buyer to make a nonverifiable revenue report $\hat{r}_t$ to the seller and adjust the revenue realization stage of the game as follows.

1. *Revenue realization*. The level of the revenue shifter $r_{t-1} \in \{r^l, r^h\}$ is realized and privately learned by the buyer. The buyer decides on a nonverifiable revenue report $\hat{r}_{t-1} \in \{r^l, r^h\}$ to the seller. The product shipped in the previous period generates revenue $R(Q_{t-1}, r_{t-1})$ to the buyer from the sale to final consumers.

Under A-terms, the buyer's report is irrelevant for optimal contract design. Since at the contracting and the payment stage both—buyer and seller—do not know the realized revenue level, any report is irrelevant for contract design and relationship continuation. Consequently, the analysis does not change when compared to Section 3.

Under Ω-terms, the seller has two options for optimal contract design (cf. Troya-Martinez, 2013, 2017). On the one side, the contract may contain report-contingent transfers and ensure truthful reporting by punishing low reports adequately. On the other side, it can be optimal to propose a "flat" contract in which the transfer size is independent of reported revenues. A principal challenge in designing the report-contingent contract is to eliminate the buyer's incentive to underreport high revenues strategically. Although we find that it is optimal to set transfers and trade volumes as in the public information case, the seller addresses the underreporting problem by suspending trade when low revenues are reported. The length of trade suspension is set to make the patient buyer indifferent between possible reports. It turns out that a high revenue report acts as a credible signal of the patient buyer's type, which structurally impacts the seller's dynamic programming problem when compared to Subsection 3.2. Alternatively, when setting a flat transfer, the seller ignores the buyer's liquidity constraint and sets the transfer such that the payment incentive constraint of the patient buyer binds. Comparing the seller's ex ante expected payoffs of both scenarios gives the following result.

PROPOSITION 5. *Under private information, in any transaction the seller finds it optimal to request a revenue report-independent transfer. Under Ω-terms, incentivizing the buyer to report revenues truthfully is never payoff-maximizing for the seller.*

Proposition 5 implies that the trade-off between relationship stability and stage payoff growth outlined in Subsection 3.3 applies also to the private information scenario. Without truthtelling incentivization, the seller's learning process under Ω-terms is identical to the public information case leading to slower information acquisition as compared to cash in advance.

As a corollary, note that under private information it is optimal to employ the relationship stability-enhancing advantages of Ω-terms only temporarily on the learning path. When the buyer has acquired sufficient type information through repeated interaction, A-terms payoff-dominate Ω-terms. The reason is that the flat stage contract under Ω-terms causes a residual buyer bankruptcy risk. Due to this, the larger stage payoffs under A-terms at the full information limit imply that these are overall more profitable in established relationships when revenue information is private. We conclude that seller trade credit provision in established relationships is more likely when he has reliable buyer revenue information available.

6. TESTABLE PREDICTIONS

Our analysis rationalizes the empirical patterns on relationship stability and the usage of payment contracts from Antràs and Foley (2015) and Garcia-Marin et al. (2020) as summarized in the Introduction. At the same time, we further qualify their empirical results by showing how they rely on the institutional properties of the destination market as well as on the information exchange between trade partners. We summarize the key predictions of our model in the following.

PREDICTION 1. *A trade relationship (irrespective of its age) is more stable and more likely survives from one transaction to the next when payment is conducted on Ω-terms as compared to A-terms. With a better quality of contract enforcement institutions in the destination market, relationship stability increases under Ω-terms and is unaffected under A-terms.*

In our model, the higher relationship stability under Ω-terms originates from the fact that only under these terms the likelihood of buyer contract compliance benefits from institutional enforcement, and from the repayment flexibility that Ω-terms give the buyer with respect to revenue shocks (as, e.g., implied by variations in final consumer demand). Thereby, we show how shocks and relationship default systematically interact with the choice of payment terms and provide a theoretical microfoundation to the reduced-form analysis of Antràs and Foley (2015). Relatedly, we provide an argument why even in the absence of a large macroeconomic shock (affecting contract compliance under both, A- and Ω-terms), one should expect larger relationship discontinuation rates under A-terms.[32] We find that optimal contract design attenuates the impacts of unanticipated shocks under Ω-terms but does not do so under A-terms.

Building on these patterns, Prediction 1 also underscores that better contract enforcement institutions increase the relationship stability under Ω-terms by constraining the nonpayment opportunities for buyers. In contrast, better institutions have no such effect under A-terms. The reason is that advance payment enables the seller to efficiently screen buyers for their reliability and thereby makes institutional contract enforcement redundant. This differential effect of institutional quality remains to be tested in future empirical work.

For a given seller with initial belief θ_0 the model predicts a unique DOSPC. Across individual sellers the ex-ante assessment of the buyer pool is likely heterogeneous and, for example, does depend on the seller's experience in the destination market (cf. Araujo et al., 2016). When the initial beliefs of sellers in an industry are sufficiently dispersed and—in model terms—some sellers do have "moderate" and fixed initial beliefs with $\theta_0 \in (\underline{\theta}_0, \overline{\theta}_0)$, then the model provides the following industry-level predictions.[33]

[32] Motivated by the global financial crisis in 2008, the analytical focus of the dynamic model in Antràs and Foley (2015) is on the impact of large macrolevel shocks on relationship stability under different payment modes. Although demand shocks in their framework reduce seller stage payoffs proportionally and cause relationship breakdown under either payment mode, our findings at the contractual level suggest that the seller's ability to condition transfer payments on shock outcomes under Ω-terms makes trade relationships systematically more stable under these terms.

[33] Prediction 2 follows from combining the theoretical results of Corollary 1 and Subsection 5.2.

PREDICTION 2. *When sellers can verify buyer revenue shocks, at the industry level the relative usage of Ω-terms to A-terms increases with the age of trade relationships. When shocks are non-verifiable, the usage of Ω-terms does not increase with relationship age.*

When revenue shocks are public information, in our model the main rationale to increase trade credit provision over time is to strengthen the resilience of relationships to revenue shocks. Although this leads to qualitatively comparable predictions on payment term transitions as in Antràs and Foley (2015), the mechanism that underlies the choice dynamics in our model is fundamentally different: In the mentioned paper, transitions are generated from the differential efficiency of the banking system in the seller's and the buyer's economy. In contrast, we show that the prediction remains valid when abstracting from specific properties of the financial system and institutional differences between countries. We argue that the outlined transitions are a direct consequence of optimal contract design when buyer revenue information is available to the seller.

The transition dynamics described above find empirical support in the transaction-level trade data analyzed in the mentioned papers, which underscores the practical relevance of the public information case of our model. For the markets studied there, our model suggests that sellers are well-aware of the revenue situation of buyers as, for example, implied by the demand fluctuations of consumers in the local buyer economy. Our model extension in Subsection 5.2 points out that when sellers cannot verify the buyer's revenue situation, they lose important flexibility to design an incentive-compatible repayment scheme under Ω-terms, which makes providing trade credit less attractive. For this case, the model predicts that in established trade relationships sellers will never find it optimal to offer trade credit to their buyers. Although the prediction on how information availability and payment term selection in trade relationships interrelate is clear cut in our model, a direct empirical test of Prediction 2 is difficult. Even though controlling for information transmission between firms may be impossible with observational trade data, an experimental setting appears to be a promising avenue to bring our informational predictions to an empirical test.

7. CONCLUSION

In this article, we have used external evidence on the usage of payment terms in interfirm trade relationships to motivate a theoretical analysis on how sellers can employ payment contracts to improve the efficiency of buyer–seller cooperation. We have developed a relational contracting model in which trade volumes and payment terms of transactions are determined endogenously, and buyer payment compliance as well as the enforcement of formal contracts are uncertain. We have shown that pre- and postshipment payment terms inhibit structurally different learning opportunities for the seller, allowing to address and improve the efficiency of trade relationships. Deciding on whether or not to provide trade credit requires the seller to prioritize between the stability and the profitability of the exchange relationship with a buyer. We have shown that the seller can resolve this trade-off in an optimal way by assessing the distribution of buyer types, based on which new trade relationships are formed.

Although it is reassuring that our model can rationalize important empirical evidence on the dynamics of firm payment contract choice (cf. Antràs and Foley, 2015), the results also suggest that the generality of the usage patterns documented in their work is limited. We have found that only if the seller can obtain reliable information on the revenues that the seller makes from final consumers can it be optimal for him to increase the provision of trade credit over time. Also beyond the topic of payment contracts, this qualifying finding points at the important role that the verifiability of information plays for the structure and evolution of trade patterns and relationships. Although reliable measures on the information transmission between trade partners may be difficult to obtain from observational data, an experimental research setup in the field or the laboratory can offer a fruitful approach to bring our predictions to an empirical test.

Although for the largest part of this article, the analysis has focused on the nonintermediated payment modes of cash in advance and open account, trade finance products provided by banks and insurance firms are also of practical relevance (cf. Niepmann and Schmidt-Eisenlohr, 2017). Our article incorporates external forms of trade finance into the discussion by analyzing and identifying the impact of trade credit insurance on the dynamically optimal choice of payment contracts. Although we show that the main mechanisms of our model are robust to the availability of such an insurance, a promising avenue for future research is to further explore the microfoundations of other relevant types of external trade finance such as letters of credit and documentary collections in a dynamic contracting framework.

APPENDIX A: THEORETICAL APPENDIX

A.1. *Proof of Lemma 1.* At the Production and Shipment stage (6) of any period, the seller will not deviate from the contract if and only if (IC_S) holds. The seller's incentive constraint ensures that making the effort to produce the contracted output plus the continuation payoff from the current relationship with a patient buyer results in a higher payoff than deviating by not producing and shipping the agreed quantity Q^A. In this latter case, the current relationship breaks down and one with a new buyer is started in the following period. Plugging explicit values for V_0^A and V_1^A into (IC_S) and simplifying gives:

$$-cQ^A + \delta_S \frac{(1-\theta_0+\gamma\theta_0(1-\delta_S))\overline{\pi}^A}{(1-\delta_S)(1-\gamma\theta_0\delta_S)} \geq \delta_S \tfrac{(1-\theta_0)\overline{\pi}^A}{(1-\delta_S)(1-\gamma\theta_0\delta_S)}. \tag{A.1}$$

Observing that $cQ^A = \overline{\pi}^A(1-\alpha)/\alpha$, we can simplify (A.1) to:

$$\delta_S \geq \frac{1-\alpha}{\gamma\theta_0} \equiv \tilde{\delta}_S. \tag{A.2}$$

For an equilibrium to exist, we need to ensure that $\tilde{\delta}_S < 1$. This is the case whenever:

$$\alpha > 1-\gamma\theta_0 \equiv \tilde{\alpha} \in (0,1) \tag{A.3}$$

holds. In this situation, the nonproduction deviation of the seller can be ruled if he is patient enough, that is, when $\delta_S \geq \tilde{\delta}_S$ holds. □

A.2. *Proof of Lemma 2.* In the following, we determine the transfer levels $\{T_t^{\Omega,l}, T_t^{\Omega,h}\}$ that maximize the seller's stage payoffs (and thereby also his ex ante expected payoffs). In general, the seller chooses $\{Q_t^{\Omega}, T_t^{\Omega,l}, T_t^{\Omega,h}\}$ such that the stage payoffs in (4) are maximized, subject to (LC_t^l), (LC_t^h), ($\text{IC}_{B,t}^{\Omega,l}$), and ($\text{IC}_{B,t}^{\Omega,h}$). Clearly, the liquidity constraints ensure that ($\text{PC}_{B,t}^{\Omega}$) holds as well.

First, note that the seller's stage payoffs increase in both $T_t^{\Omega,l}$ and $T_t^{\Omega,h}$. We can start by requiring that (LC_t^l) binds and set $T_t^{\Omega,l} = R(Q_t, r^l) \approx 0$. This simplifies ($\text{IC}_{B,t}^{\Omega,h}$) to:

$$-T_t^{\Omega,h} + \frac{\delta_B\gamma}{1-\delta_B(1-\gamma)}R(Q_t) \geq 0. \tag{A.4}$$

Observe that the maximal value of $T_t^{\Omega,h}$ for which both, (A.4) and (LC_t^h), hold is the point where (A.4) binds with equality. Hence, the seller will set $T_t^{\Omega,h} = \delta_B\gamma/(1-\delta_B(1-\gamma))R(Q_t)$ to extract the maximal amount of rents.

A comparison of ($\text{IC}_{B,t}^{\Omega,l}$) and ($\text{IC}_{B,t}^{\Omega,h}$) reveals that $T_t^{\Omega,h} \geq T_t^{\Omega,l}$ must hold in order for all constraints of the maximization problem to be satisfied. This is always the case. □

A.3. *A Rationale for Avoiding Buyer Bankruptcy under Cash in Advance.* Alternative to the case discussed in Subsection 3.1 where the seller lets the patient buyer go bankrupt after a low revenue shock, he can decide to repay the transfer $T_t^A = \delta_B R(Q^A, r_E) = \overline{\pi}^A/\alpha$ to the buyer and thereby save her from bankruptcy. When repaying the buyer, the seller's expected payoff at the point when the shock occurs can be obtained from the following programming problem:

$$V_0^{A,r} = -\alpha^{-1}\overline{\pi}^A + \overline{\pi}^A + \delta_S\left[\gamma V_1^{A,r} + (1-\gamma)V_0^{A,r}\right],$$
$$V_1^{A,r} = \overline{\pi}^A + \delta_S\left[\gamma V_1^{A,r} + (1-\gamma)V_0^{A,r}\right].$$

Note that if the seller repays in one period, he repays in all periods where a shock occurs since the problem is fully stationary. Solving the problem for $V_0^{A,r}$ gives:

$$\Pi^{A,r} = \frac{1-\alpha^{-1}(1-\delta_S\gamma)}{(1-\delta_S)}\overline{\pi}^A.$$

Hence, in any period under the payment sequence $(A, \ldots)$, the seller prefers to let the patient buyer go bankrupt instead of keeping him in the relationship by repaying the transfer if and only if:

$$\Pi^A > \Pi^{A,r} \qquad \Leftrightarrow \qquad \theta_0 < \frac{1}{\alpha + \delta_S\gamma} \equiv \underline{\theta}_0^*.$$

Intuitively, when there are not too many myopic buyers in the population rematching to a new one is more profitable for the seller than keeping the current patient buyer as maintaining the buyer's liquidity is costly.

A.4. *Derivation of the Ex Ante Expected Payoffs* Π^Ω. This appendix complements the analysis of the main text by providing a nonrecursive expression of the seller's ex ante expected payoffs under open account terms. We proceed in two steps. First, we rewrite the period t-version of Equation (5) by repeatedly substituting in the value functions of all subsequent periods. Second, we solve the resulting equation for period $t = 0$. By substituting in, we can rewrite (5) to:

$$\text{(A.5)}\quad V_t^\Omega = \overline{\pi}^\Omega\left[\Lambda_t^{\frac{1}{\alpha}} + \sum_{i=t+1}^{\infty}\delta_S^{i-t}\Lambda_i^{\frac{1}{\alpha}}\prod_{j=t}^{i-1}\Lambda_j\right] + V_0^\Omega\left[\delta_S(1-\Lambda_t) + \sum_{i=t}^{\infty}\delta_S^{i-t+2}(1-\Lambda_{i+1})\prod_{j=t}^{i}\Lambda_j\right].$$

Observing that $\prod_{j=t}^{i}\Lambda_j = (1-\theta_0(1-\lambda^{i+1}))/(1-\theta_0(1-\lambda^t))$, we can simplify (A.5) to:

$$\text{(A.6)}\qquad V_t^\Omega = \frac{1}{1-\theta_0(1-\lambda^t)}\left[\overline{\pi}^\Omega\sum_{i=t}^{\infty}\delta_S^{i-t}\Lambda_i^{\frac{1}{\alpha}}(1-\theta_0(1-\lambda^i)) + \delta_S V_0^\Omega\left(\frac{\theta_0\lambda^t(1-\lambda)}{1-\lambda\delta_S}\right)\right].$$

Now suppose that $t = 0$. Solving the resulting version of (A.6) for V_0^Ω gives:

$$\Pi^\Omega = \frac{1-\lambda\delta_S}{1-\delta_S(\theta_0+(1-\theta_0)\lambda)}\overline{\pi}^\Omega\sum_{t=0}^{\infty}\delta_S^t\Lambda_t^{\frac{1}{\alpha}}(1-\theta_0(1-\lambda^t)).$$

A.5. *Proof of Proposition 3.* For the proof, we re-express the value functions in (2) and (5) to introduce additional notation allowing us to distinguish more explicitly between the current period belief θ_t, $t \geq 0$, and the initial period belief θ_0. For payment contract type $i \in \mathcal{F}$, we denote the corresponding value function applicable in period t of the trade relationship as $V_t^i(\theta_t, \theta_0)$ in the following. We have:

$$\begin{aligned} V_t^A(\theta_t, \theta_0) &= (1-\theta_t)\overline{\pi}^A + \delta_S[\gamma(1-\theta_t)V_{t+1}(0, \theta_0) + (1-\gamma(1-\theta_t))V_{t+1}(\theta_0, \theta_0)], \\ V_t^\Omega(\theta_t, \theta_0) &= \pi_t^\Omega + \delta_S\big[(1-\theta_t(1-\lambda))V_{t+1}(\theta_{t+1}^\Omega, \theta_0) + \theta_t(1-\lambda)V_{t+1}(\theta_0, \theta_0)\big], \end{aligned} \tag{A.7}$$

where $V_t(\theta_t, \theta_0) \in \{V_t^A(\theta_t, \theta_0), V_t^\Omega(\theta_t, \theta_0)\}$. When the seller is interested in setting the DOSPC, for every belief θ_t in any period $t \geq 0$, he sets $F_t \in \mathcal{F}$ such that $V_t(\theta_t, \theta_0) = \max\{V_t^A(\theta_t, \theta_0), V_t^\Omega(\theta_t, \theta_0)\}$. In the following steps, we derive conditions ensuring that $\mathcal{F}^D$ represents the full set of possible DOSPCs.

Step 1: For limiting initial beliefs, $\theta_0 \to 0$ **and** $\theta_0 \to 1$, **we show that only** $F_t = (A, \ldots)$ **and** $F_t = (\Omega, \ldots)$, **respectively, can be dynamically optimal**.

First, consider the situation where $\theta_0 \to 1$. We get $\lim_{\theta_0 \to 1} V_t^\Omega(\theta_t, \theta_0) = \lambda^{\frac{1}{\alpha}}\overline{\pi}^\Omega/(1-\delta_S) > \lim_{\theta_0 \to 1} V_t^A(\theta_t, \theta_0) = 0$. Since the value function expressions are independent of θ_t, it follows that $F_t = (\Omega, \ldots)$ is optimal in this case. Next, consider the situation where $\theta_0 \to 0$. This gives:

$$\lim_{\theta_0 \to 0} V_t^\Omega(\theta_t, \theta_0) = \left(\frac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}} \frac{\overline{\pi}^A}{1-\delta_S} < \lim_{\theta_0 \to 0} V_t^A(\theta_t, \theta_0) = \frac{\overline{\pi}^A}{1-\delta_S}.$$

Again, by the independence of the expressions of θ_t, it follows that $F_t = (A, \ldots)$ must be optimal.

Step 2: We show that if the seller is sufficiently patient the only additional payment sequence that can become dynamically optimal is $F_t = (A, \Omega, \Omega, \ldots)$.

From Step 1, we know that both, A- and Ω-terms can be optimal in the initial period. First, let us consider the case where A-terms are chosen initially ($F_0 = A$). Then, due to the separating nature of the optimal stage contract under these terms, the game reaches the full information limit in the following period given that the relationship continues. Since at this limit the game reaches an absorbing state, the payment contract that is optimal in $t = 1$ is also optimal in all further periods. As a consequence, the only payment contract sequences that can become optimal when $F_0 = A$ are $(A, \ldots)$ and $(A, \Omega, \Omega, \ldots)$. At the contracting stage in $t = 1$, the seller chooses the payment terms $F_1 \in \{A, \Omega\}$ by comparing the following value functions:

$$V_1^A(0, \theta_0) = \frac{(1-\delta_S\theta_0)\overline{\pi}^A}{(1-\delta_S)(1-\delta_S\gamma\theta_0)} \quad \text{and} \quad V_1^\Omega(0, \theta_0) = \left(\frac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}} \frac{\overline{\pi}^A}{1-\delta_S},$$

and will prefer Ω-terms over A-terms in all periods $t > 0$ if and only if:

$$V_1^\Omega(0, \theta_0) > V_1^A(0, \theta_0) \quad \Leftrightarrow \quad \theta_0 > \frac{1-\left(\frac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}}}{\delta_S\left(1-\gamma\left(\frac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}}\right)} \equiv \underline{\theta}_0.$$

Clearly, $\underline{\theta}_0 > 0$. Moreover, since $\partial\underline{\theta}_0/\partial\delta_S < 0$ and $\lim_{\delta_S \to 1} \underline{\theta}_0 < 1$, there exists $\delta_S' \in (0, 1)$ such that $\underline{\theta}_0 \in (0, 1)$ holds for all $\delta_S > \delta_S'$.

Second, consider the case where Ω-terms are chosen initially ($F_0 = \Omega$), in which case, the seller's belief is updated according to Bayes' rule when the initial transaction is successful and $\theta_1 = \theta_1^\Omega$. In the following, we show that whenever it is optimal to choose Ω-terms initially, it is never optimal to switch to A-terms in a later transaction. This establishes that the DOSPC is $F = (\Omega, \dots)$ in this case.

For the following arguments, we first need to establish the comparative statics of the value functions with respect to the current period belief θ_t. Observe that the flow payoffs in both value functions in (A.7) are decreasing in θ_t. From this it directly follows that $\partial V_t^A(\theta_t, \theta_0)/\partial\theta_t < 0$ and $\partial V_t^\Omega(\theta_t, \theta_0)/\partial\theta_t < 0$. Moreover, the flow payoffs under A-terms and (due to the immediate buyer separation under A-terms) also $V_t^A(\theta_t, \theta_0)$ are linear in θ_t and, hence, $\partial^2 V_t^A(\theta_t, \theta_0)/\partial\theta_t^2 = 0$. In contrast, observe that:

$$\text{(A.8)} \quad \frac{\partial^2 V_t^\Omega(\theta_t, \theta_0)}{\partial\theta_t^2} = \frac{(1-\alpha)(1-\lambda)^2\pi_t^\Omega}{\alpha^2\Lambda_t^2} - 2(1-\lambda)\delta_S\frac{\partial V_{t+1}(\theta_{t+1}^\Omega, \theta_0)}{\partial\theta_t} + \delta_S\Lambda_t\frac{\partial^2 V_{t+1}(\theta_{t+1}^\Omega, \theta_0)}{\partial\theta_t^2},$$

where $\operatorname{sgn}(\partial V_{t+1}(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_t) = \operatorname{sgn}(\partial V_{t+1}(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_{t+1}) = -1$ since $\partial\theta_{t+1}^\Omega/\partial\theta_t > 0$. Moreover, we conclude that $\partial^2 V_{t+1}(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_t^2 \geq 0$ using a case distinction: When A-terms are chosen in $t+1$, we have $\partial^2 V_{t+1}^A(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_t^2 = 0$. When Ω-terms are chosen in $t+1$, it follows from $\partial\theta_{t+1}^\Omega/\partial\theta_t > 0$ and $\partial^2\theta_{t+1}^\Omega/\partial\theta_t^2 > 0$ that $\operatorname{sgn}(\partial^2 V_{t+1}^\Omega(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_t^2) = \operatorname{sgn}(\partial^2 V_{t+1}^\Omega(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_{t+1}^2)$. Also note that at $\theta_t = 0$, we have:

$$\frac{\partial^2 V_t^\Omega(0, \theta_0)}{\partial\theta_t^2} = \frac{1}{1-\delta_S}\left[\frac{(1-\alpha)(1-\lambda)^2\overline{\pi}^\Omega}{\alpha^2} - 2(1-\lambda)\delta_S\frac{\partial V_{t+1}^\Omega(0, \theta_0)}{\partial\theta_t}\right] > 0.$$

Since the first two addends in (A.8) are positive for all $\theta_t \in [0, 1)$ it follows from the above observations that $\partial^2 V_{t+1}(\theta_{t+1}^\Omega, \theta_0)/\partial\theta_t^2 > 0$ in the present case. Hence, $\partial^2 V_t^\Omega(\theta_t, \theta_0)/\partial\theta_t^2 > 0$ holds.

From the limit properties derived in Step 1, it follows that there exists a neighborhood of initial beliefs around the limit belief $\theta_0 \to 1$ for which $V_0^\Omega(\theta_0, \theta_0) > V_0^A(\theta_0, \theta_0)$ holds, that is, Ω-terms are chosen initially. Consider now any such level of the initial belief θ_0. In this situation, the seller evaluates the comparatively small learning gains available under Ω-terms (and as prescribed by updating rule θ_1^Ω) as preferable to the type-separation outcome under A-terms (in which case $\theta_1 = 0$). Together with the facts that $V_t^A(\theta_t, \theta_0)$ decreases linearly in θ_t and that $V_t^\Omega(\theta_t, \theta_0)$ is decreasing and strictly convex in θ_t, it follows that $V_t^\Omega(\theta_t, \theta_0) > V_t^A(\theta_t, \theta_0)$ holds also for all $t > 0$ in this situation. Hence, $F = (\Omega, \dots)$ must be optimal. As an intermediate result, it follows that $F \in \mathcal{F}^D$ for all $\delta_S > \delta_S'$.

Step 3: Managing the buyer bankruptcy risk for sequences $F = (A, \dots)$ **and** $F = (A, \Omega, \Omega, \dots)$.

Whenever a contract C_t is accepted on A-terms in the context of sequences $F = (A, \dots)$ or $F = (A, \Omega, \Omega, \dots)$ the seller learns that the buyer is patient and therefore may want to save her from bankruptcy when $r_t = r^l$. In the following, we show that when the seller is sufficiently patient and can freely select the payment terms of every transaction it is never optimal to safe the buyer under sequence $(A, \dots)$. This stands in contrast to the seller's choice for sequence $(A, \Omega, \Omega, \dots)$ where saving the buyer can be optimal when θ_0 is high.

First, let us consider the scenario where $F = (A, \dots)$ is optimal. We have shown in this Appendix that the seller prefers rematching to a new buyer instead of saving the current buyer from bankruptcy if and only if $\theta_0 < \underline{\theta}_0^* = 1/(\alpha + \delta_S\gamma)$. Acknowledging the results of Step 2, the seller lets the buyer go bankrupt for all relevant model parameterizations if and only if $\underline{\theta}_0^* > \underline{\theta}_0$. Noting that $\partial\underline{\theta}_0^*/\partial\delta_S < 0$, $\partial\underline{\theta}_0/\partial\delta_S < 0$ and $\lim_{\delta_S\to 1}\underline{\theta}_0^* > \lim_{\delta_S\to 1}\underline{\theta}_0$ we conclude that there exists $\delta_S^r \in [0, 1)$ such that $\underline{\theta}_0^* > \underline{\theta}_0$ for all $\delta_S > \delta_S^r$.

Next, let us continue with the case where $F = (A, \Omega, \Omega, \dots)$. Under the assumption of letting the buyer go bankrupt when $r_0 = r^l$, we can derive the seller's ex ante expected payoffs from solving the following recursion for $V_0^{A\Omega}$:

$$V_0^{A\Omega} = (1-\theta_0)\overline{\pi}^A + \delta_S\big[\gamma(1-\theta_0)V_1^{A\Omega} + (1-\gamma(1-\theta_0))V_0^{A\Omega}\big], \qquad V_1^{A\Omega} = \frac{\overline{\pi}^\Omega}{1-\delta_S}.$$

The solution is:

$$\Pi^{A\Omega} = \frac{(1-\theta_0)(\delta_S\gamma\overline{\pi}^{\Omega} + (1-\delta_S)\overline{\pi}^A)}{(1-\delta_S)(1-\delta_S(1-\gamma(1-\theta_0)))}.$$

Suppose now that $r_0 = r^l$ and consider the seller's decision at the beginning of period $t = 1$ whether or not to let the buyer go bankrupt. When saving the buyer, the seller's current period expected payoffs are:

$$\Pi^{A\Omega,r} = -\frac{\overline{\pi}^A}{\alpha} + \frac{\overline{\pi}^{\Omega}}{1-\delta_S},$$

and the seller prefers to rematch to a new buyer if and only if:

$$\begin{aligned} \Pi^{A\Omega} > \Pi^{A\Omega,r} \qquad & \Leftrightarrow \quad \overline{\pi}^A\left(\tfrac{1-\theta_0}{1-\delta_S(1-\gamma(1-\theta_0))} + \tfrac{1}{\alpha}\right) > \tfrac{\overline{\pi}^{\Omega}}{1-\delta_S(1-\gamma(1-\theta_0))} \\ & \Leftrightarrow \quad \theta_0 < \tfrac{1}{\alpha+\delta_S\gamma}\left[\alpha\left(1-\left(\tfrac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}}\right) + 1 - \delta_S(1-\gamma)\right] \equiv \underline{\theta}_0^{**}. \end{aligned}$$

Let us now compare the thresholds $\underline{\theta}_0^{**}$ and $\underline{\theta}_0$. We have $\partial\underline{\theta}_0/\partial\delta_S < 0$, $\lim_{\delta_S\to 0}\underline{\theta}_0 = \infty$, $\lim_{\delta_S\to 1}\underline{\theta}_0 = (1-\tilde{x})/(1-\gamma\tilde{x}) \in (0,1)$ as well as $\partial\underline{\theta}_0^{**}/\partial\delta_S < 0$, $\lim_{\delta_S\to 0}\underline{\theta}_0^{**} = (1+\alpha)/\alpha > 1$, and

$$\lim_{\delta_S\to 1}\underline{\theta}_0^{**} = \frac{\alpha(1-\tilde{x})+\gamma}{\alpha+\gamma} \in (0,1), \quad \text{where} \quad \tilde{x} = \left(\frac{\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}} \in (0,1).$$

Moreover observing that:

$$\lim_{\delta_S\to 1}\underline{\theta}_0^{**} > \lim_{\delta_S\to 1}\underline{\theta}_0 \quad \Leftrightarrow \quad \hat{x} \equiv \alpha(\tilde{x}-1) + 1 - \gamma > 0,$$

noting that $\partial\hat{x}/\partial\alpha < 0$, and $\lim_{\alpha\to 1}\hat{x} = \delta_B(1-\gamma)\gamma/(1-\delta_B(1-\gamma)) > 0$, we can safely conclude that there exists a unique $\delta_S^{rr} \in (0,1)$ such that $\underline{\theta}_0^{**} > \underline{\theta}_0$ for all $\delta_S > \delta_S^{rr}$. In this situation, whenever the sequence $F = (A, \Omega, \Omega, \ldots)$ is employed the seller does not save an illiquid patient buyer from bankruptcy in the initial transaction when his initial belief of facing a myopic type is relatively low (i.e., when $\theta_0 \in (\underline{\theta}_0, \underline{\theta}_0^{**})$). In contrast, when the belief is high ($\theta_0 > \underline{\theta}_0^{**}$)), the seller prefers to save the buyer after a successful initial transaction. The trade-off at work in this decision is fully equivalent to that of the sequence $F = (A, \ldots)$ discussed in Subsection 3.1.

For later use, let us note that the seller's ex ante expected payoff at $t = 0$ for sequence $(A, \Omega, \Omega, \ldots)$ conditional saving the patient buyer after a liquidity shock in the initial transaction are:

$$\Pi^{A\Omega,s} = \frac{1-\theta_0}{1-\delta_S\theta_0}\left[\left(1-\frac{\delta_S(1-\gamma)}{\alpha}\right)\overline{\pi}^A + \frac{\delta_S}{1-\delta_S}\overline{\pi}^{\Omega}\right].$$

Step 4: The nonshipment deviation for sequence $F = (A, \Omega, \Omega, \ldots)$.

Remains to rule out the nonshipment deviation for the seller under the payment sequence $F = (A, \Omega, \Omega, \ldots)$ (analogy to Lemma 1). A deviation by the seller by not procuring the product in the initial transaction on A-terms is ruled out if and only if:

$$-cQ^A + \delta_S V_1^{A\Omega} \geq \delta_S V_0^{A\Omega} \quad \Leftrightarrow \quad \Gamma_1 \equiv \left(\frac{\delta_S\gamma}{1-\delta_B(1-\gamma)}\right)^{\frac{1}{\alpha}} - (1-\theta_0) \geq \frac{(1-\alpha)(1-\delta_S(1-\gamma(1-\theta_0)))}{\alpha\delta_S} \equiv \Gamma_2.$$

We want to derive parameter requirements such that $\Gamma_1 \geq \Gamma_2$ holds. First, note that $\partial\Gamma_2/\partial\alpha < 0$, $\partial^2\Gamma_2/\partial\alpha^2 > 0$, $\lim_{\alpha\to 0}\Gamma_2 = \infty$, and $\lim_{\alpha\to 1}\Gamma_2 = 0$. Second, note that $\partial\Gamma_1/\partial\alpha > 0$ and $\lim_{\alpha\to 0}\Gamma_1 = -(1-\theta_0)$. Hence, there exists a unique $\tilde{\alpha}^o \in (0,1)$ such that $\Gamma_1 \geq \Gamma_2$ for all $\alpha > \tilde{\alpha}^o$ if and only if:

$$\lim_{\alpha\to 1}\Gamma_1 > 0 \quad \Leftrightarrow \quad \delta_S > \gamma^{-1}(1-\theta_0)(1-\delta_B(1-\gamma)) \equiv \tilde{\delta}_S^o.$$

We need to ensure that $\tilde{\delta}_S^o \in (0,1)$. This is the case if and only if:

$$\text{(A.9)} \qquad \delta_B > \frac{1-\theta_0-\gamma}{(1-\theta_0)(1-\gamma)} \equiv \underline{\delta}_B \in (0,1).$$

We conclude that the nonshipment deviation under the sequence $F = (A, \Omega, \Omega, \ldots)$ is ruled out whenever $\alpha > \tilde{\alpha}^o$, $\delta_S > \tilde{\delta}_S^o$ and $\delta_B > \underline{\delta}_B$ hold.

Step 5: Summary of the parameter constraints.

Let us summarize all the parameter requirements that we derived above and in Lemma 1, which allow us to conclude that $F \in \mathcal{F}^D$. Besides $\delta_B > \underline{\delta}_B$, the constraints are:

$$\text{(A.10)} \qquad \begin{aligned} &\alpha > \max\{\tilde{\alpha}, \tilde{\alpha}^o\} \equiv \underline{\alpha} \in (0,1),\\ &\delta_S > \max\{\tilde{\delta}_S, \tilde{\delta}_S^o, \delta_S', \delta_S^r, \delta_S^{rr}\} \equiv \underline{\delta}_S \in (0,1).\square \end{aligned}$$

A.6. *Proof of Corollary 1.* We begin by deriving essential comparative statics of the ex ante expected payoff functions. First, let us compare the limit properties with respect to the initial belief θ_0. Observe that $\lim_{\theta_0\to 1}\Pi^{A\Omega} = \lim_{\theta_0\to 1}\Pi^{A\Omega,s} = \lim_{\theta_0\to 1}\Pi^{A} = 0 < \lim_{\theta_0\to 1}\Pi^{\Omega} = \lambda^{\frac{1}{\alpha}}\overline{\pi}^{\Omega}/(1-\delta_S)$. Moreover, we have:

$$\lim_{\theta_0\to 0}\Pi^{A\Omega} = \frac{\gamma\delta_S\overline{\pi}^{\Omega} + (1-\delta_S)\overline{\pi}^{A}}{(1-\delta_S)(1-\delta_S(1-\gamma))}, \qquad \lim_{\theta_0\to 0}\Pi^{A} = \frac{\overline{\pi}^{A}}{1-\delta_S}, \qquad \lim_{\theta_0\to 0}\Pi^{\Omega} = \frac{\overline{\pi}^{\Omega}}{1-\delta_S},$$

for which holds $\lim_{\theta_0\to 0}\Pi^{A} > \lim_{\theta_0\to 0}\Pi^{A\Omega} > \lim_{\theta_0\to 0}\Pi^{\Omega}$. Next, we derive essential functional properties of Π^A, $\Pi^{A\Omega}$, $\Pi^{A\Omega,s}$, and Π^{Ω}. We get:

$$\begin{gathered}
\frac{\partial\Pi^A}{\partial\theta_0} = -\frac{(1-\delta_S\gamma)\overline{\pi}^A}{(1-\delta_S)(1-\delta_S\gamma\theta_0)^2} < 0, \qquad \frac{\partial^2\Pi^A}{\partial\theta_0^2} = -\frac{2\delta_S\gamma(1-\delta_S\gamma)\overline{\pi}^A}{(1-\delta_S)(1-\delta_S\gamma\theta_0)^3} < 0,\\
\frac{\partial\Pi^{A\Omega}}{\partial\theta_0} = -\frac{(1-\delta_S)\overline{\pi}^A+\delta_S\gamma\overline{\pi}^{\Omega}}{(1-\delta_S+\delta_S\gamma(1-\theta_0))^2} < 0, \qquad \frac{\partial^2\Pi^{A\Omega}}{\partial\theta_0^2} = -\frac{2\delta_S\gamma[(1-\delta_S)\overline{\pi}^A+\delta_S\gamma\overline{\pi}^{\Omega}]}{(1-\delta_S+\delta_S\gamma(1-\theta_0))^3} < 0,\\
\frac{\partial\Pi^{A\Omega,s}}{\partial\theta_0} = \frac{-(1-\delta_S)}{(1-\delta_S\theta_0)^2}\left[\frac{\alpha-\delta_S(1-\gamma)}{\alpha}\overline{\pi}^A + \frac{\delta_S}{1-\delta_S}\overline{\pi}^{\Omega}\right] < 0,\\
\frac{\partial^2\Pi^{A\Omega,s}}{\partial\theta_0^2} = \frac{-2\delta_S(1-\delta_S)}{(1-\delta_S\theta_0)^3}\left[\frac{\alpha-\delta_S(1-\gamma)}{\alpha}\overline{\pi}^A + \frac{\delta_S}{1-\delta_S}\overline{\pi}^{\Omega}\right] < 0.
\end{gathered}$$

From these arguments, part (a) of the corollary follows: On the one side, note that for sufficiently small (respectively high) values of θ_0, $F = (A, \ldots)$ (respectively $F = (\Omega, \ldots)$) is payoff-maximizing for the seller. As established in the proof of Proposition 3, also observe that:

$$\Pi^{A\Omega} > \Pi^{A} \quad \Leftrightarrow \quad \theta_0 > \underline{\theta}_0 \in (0,1).$$

From this we can also conclude that $(\Omega, \ldots)$ is never optimal for any $\theta_0 < \underline{\theta}_0$. Clearly, due to the limit properties of the payoff functions for $\theta_0 \to 1$, only $(\Omega, \ldots)$ can be optimal in this case.

For part (b) of the corollary, we need to establish an additional regularity condition to ensure that Π^{Ω} is decreasing and concave in θ_0 as well. These conditions ensure existence of a unique $\overline{\theta}_0 \in (\underline{\theta}_0, 1)$ such that $\max\{\Pi^{A\Omega}, \Pi^{A\Omega,s}\} > \max\{\Pi^{A}, \Pi^{\Omega}\}$ for all $\theta_0 \in (\underline{\theta}_0, \overline{\theta}_0)$ and $\Pi^{\Omega} > \max\{\Pi^{A}, \Pi^{A\Omega}, \Pi^{A\Omega,s}\}$ for all $\theta_0 > \overline{\theta}_0$. Due to the complex geometric series expression in (6) we proceed showing concavity of Π^{Ω} in two steps. First, we analytically derive two parameter conditions on every element of the payoff series that alone ensure the desired functional property of Π^{Ω}. Since these constraints turn out overly restrictive, in a second step we show in a numerical simulation that one of the two constraints does not bind when looking at the payoff series as a whole. Overall, we argue that only the constraint $\alpha > \overline{\alpha}$ stated in the corollary is necessary to ensure concavity.

To proceed, let us define $\Pi^{\Omega} = \sum_{t=0}^{\infty} \Pi_t^{\Omega}$, where:

$$\Pi_t^{\Omega} \equiv \frac{(1-\lambda\delta_S)(1-\theta_0(1-\lambda^t))}{1-\delta_S(\theta_0+(1-\theta_0)\lambda)}\delta_S^t \Lambda_t^{\frac{1}{\alpha}} \overline{\pi}^{\Omega}.$$

We have:

$$\frac{\partial \Pi_t^{\Omega}}{\partial \theta_0} < 0 \quad \Leftrightarrow \quad (1-\lambda)\lambda^t(1-\delta_S\lambda-\delta_S\theta_0(1-\lambda)) + \alpha(1-\delta_S-\lambda^t(1-\delta_S\lambda))(1-\theta_0(1-\lambda^{t+1})) > 0,$$

which holds for every element of the payoff series and every value of α if and only if:

$$\text{(A.11)} \qquad \xi \equiv \delta_S(1+\lambda) - 1 < 0.$$

Moreover, we have:

$$\frac{\partial^2 \Pi_t^{\Omega}}{\partial \theta_0^2} < 0 \qquad \Leftrightarrow \qquad K \equiv \tfrac{1-\alpha}{\alpha}\Delta - 2\delta_S(1-\lambda)[E+\alpha Z] < 0,$$

$$\text{where} \quad \Delta \equiv \tfrac{(1-\delta_S\lambda-\delta_S\theta_0(1-\lambda))^2(1-\lambda)\lambda^t}{(1-\theta_0(1-\lambda^{t+1}))^2(1-\theta_0(1-\lambda^t))} > 0, \quad E \equiv \tfrac{(1-\delta_S\lambda-\delta_S\theta_0(1-\lambda))(1-\lambda)\lambda^t}{(1-\theta_0(1-\lambda^{t+1}))} > 0,$$

$$\text{and} \qquad Z \equiv 1-\delta_S-\lambda^t(1-\delta_S\lambda).$$

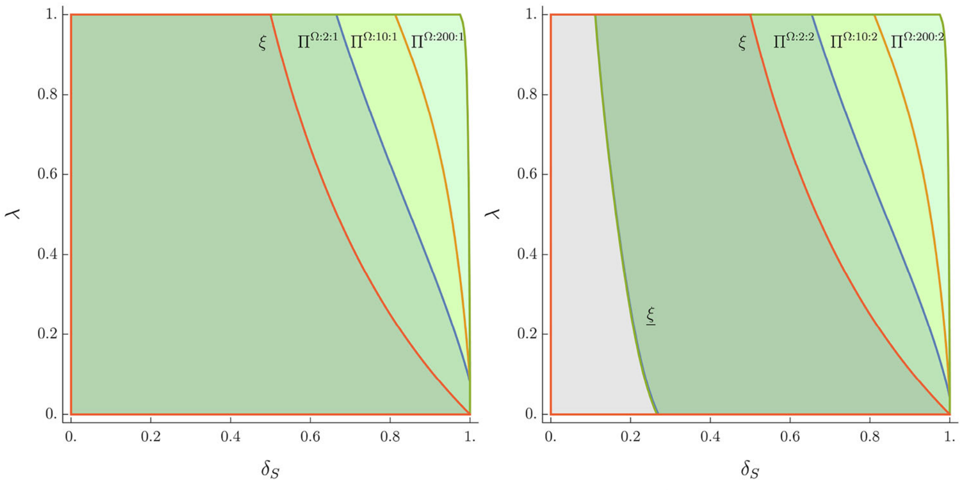
When $\xi < 0$ holds, we have $Z > 0$ and hence $\partial K/\partial\alpha < 0$ with $\lim_{\alpha\to 1} K < 0$ and $\lim_{\alpha\to 0} K = \infty$. This implies existence of a unique $\alpha^* \in (0,1)$ such that Π_t^{Ω} is concave for all $\alpha > \alpha^*$. By definition, it follows that Π^{Ω} is decreasing and concave under conditions (A.11) and $\alpha > \alpha^*$ as well.

In the next step, we show by simulation that constraint (A.11) is a relict that results from considering single payoff series elements in isolation and that disappears when numerically approximating the derivative of the full payoff series. To proceed, let us define:

$$\Pi^{\Omega:k:l} \equiv \sum_{t=0}^{k} \frac{\partial^l \Pi_t^{\Omega}}{\partial \theta_0^l},$$

which is the lth derivative of Π^{Ω} when considering the first k elements of the payoff series.

Figure A.1 illustrates that the constraint $\xi < 0$ (representing a joint upper bound on parameters δ_S and λ) loses all its relevance when more and more elements of the payoff series are included. The figure depicts in color the parameter combinations for which the derivatives of Π^{Ω} are negative. As k increases the upper bound below which this property of the derivatives holds moves to the northeast corner of the respective figure indicating that $\partial^l \Pi^{\Omega}/\partial\theta_0^l < 0$, $l = 1, 2$, also for large values of δ_S and λ. Note that we conducted the simulation over the entire value ranges of parameters θ_0 and α and the result are qualitatively unvaried throughout.



(a) $\Pi^{\Omega:k:1} < 0$ *and* $\xi < 0$.

(b) $\Pi^{\Omega:k:2} < 0$ *and* $\xi < 0$.

FIGURE A.1

NUMERICAL SIMULATION RESULTS FOR $\Pi^{\Omega:k:l}$ $(\theta_0 = 0.7, \alpha = 0.8)$

Moreover, note from Figure A.1b that for Π^{Ω} to be concave the seller must be sufficiently patient, that is, δ_S must be larger than $\underline{\xi}$. Additional simulations show that—in the figure—$\underline{\xi}$ moves to the left with α increasing and when $\alpha \to 1$ the constraint vanishes. This is consistent with the analytical property derived for $\partial^2\Pi_t^{\Omega}/\partial\theta_0^2$ and reinforces our claim that for sufficiently high values of α the payoff function Π^{Ω} is in fact concave.

In sum, we conclude that whenever $\alpha > \max\{\underline{\alpha}, \alpha^*\} \equiv \overline{\alpha}$ part (b) of the Corollary applies and the parameter thresholds $\underline{\theta}_0$ and $\overline{\theta}_0$ uniquely pin down the DOSPC. □

A.7. *Generalization of the Revenue Shock Distribution.* In this appendix, we generalize the model to account for revenue shocks of arbitrary size and assume that $r_t \in \{r^h, r^l\}$ with $r^h > r^l > 0$. As in the main text, we denote by $\gamma \in (0, 1)$ the probability that the revenue level is high, that is, $r_t = r^h$. Assuming larger values of $r^l > 0$ makes the analysis of both, the cash-in-advance and the open account payment scenario, more involved. Under A-terms, depending on the parameterization of the revenue distribution, additional transfer strategies can be optimal for the seller and require further case distinctions in Lemma 1. Under Ω-terms, the seller now finds it optimal to request a nonzero transfer from the seller in the low revenue state which requires us to account for additional nonpayment incentives of the buyer (implying adjustments to Lemma 2). We discuss the changes to the analysis of Section 3 in the following.

A.7.1. *Cash-in-advance terms.* Although designing a contract that avoids the risk of buyer bankruptcy in the low-revenue state altogether is never optimal when $r^l \to 0$, the situation changes when r^l is larger and we need to distinguish two cases. On the one side, just as in the main text the seller may want to set the transfer to $T_t^{A,h} = \delta_B R(Q_t, r_E)$ such that $(\text{PC}_{B,t}^{A})$ binds and extract all rents from the patient buyer. In this situation, the seller accepts that the buyer goes bankrupt when the low revenue state is realized. Alternatively, he can set the transfer to $T_t^{A,l} = R(Q_t, r^l) < T_t^{A,h}$ such that the liquidity constraint in the low-revenue state binds. This ensures that the trade relationship with the patient buyer is maintained in all revenue states.

Since revenue shocks are i.i.d. and the seller's learning about the buyer type does not depend on the transfer size, the seller's optimal decision between $T_t^{A,h}$ and $T_t^{A,l}$ does not vary over transactions. Hence, we can obtain the optimal transfer decision from comparing the seller's ex ante expected payoffs when the transfer is fixed to either $T^{A,h}$ or $T^{A,l}$ for the entire relationship (the time index is dropped). In the following, we call the seller's choice $T^A \in \{T^{A,l}, T^{A,h}\}$ his *transfer strategy* under A-terms. For a given transfer strategy, the seller sets to trade volume by maximizing (1), and we denote the corresponding trade volumes by $Q^{A,h}$ and $Q^{A,l}$, respectively.

The following Lemma A.1 gives a unique condition on the revenue state distribution determining which of the two transfer levels is optimal for the seller and summarizes the corresponding trade volumes and profits.

LEMMA A.1. *Suppose that $\delta_B \geq r^l/r_E$. Then there exists a unique value*

$$\hat{r} = \frac{\gamma}{\frac{1}{\delta_B}\left(\frac{1-\gamma\theta_0\delta_S}{1-\theta_0\delta_S}\right)^{\alpha} - 1 + \gamma} \in (0,1)$$

such that setting the transfer to $T^{A,h} = \delta_B R(Q^{A,h}, r_E)$ in all transactions maximizes the seller's ex ante expected payoffs if and only if $r^l \leq r^h\hat{r}$, and setting it to $T^{A,l} = R(Q^{A,l}, r^l)$ in all transactions does so otherwise. Since any spot contract under A-terms is separating, trade volumes do not vary over time and are given as:

$$Q^A = \begin{cases} (r_E\delta_B/c)^{\frac{1}{\alpha}} & \equiv Q^{A,h} \quad \text{if} \quad r^l \leq r^h\hat{r}, \\ (r^l/c)^{\frac{1}{\alpha}} & \equiv Q^{A,l} \quad \text{if} \quad r^l > r^h\hat{r}. \end{cases} \tag{A.12}$$

The corresponding seller stage payoffs, conditional on contract acceptance, are:

$$\overline{\pi}^A = \begin{cases} (r_E\delta_B)^{\frac{1}{\alpha}} c^{\frac{\alpha-1}{\alpha}} \alpha/(1-\alpha) \equiv \overline{\pi}^{A,h} & \text{if} \quad r^l \leq r^h\hat{r}, \\ (r^l)^{\frac{1}{\alpha}} c^{\frac{\alpha-1}{\alpha}} \alpha/(1-\alpha) \equiv \overline{\pi}^{A,l} & \text{if} \quad r^l > r^h\hat{r}. \end{cases} \tag{A.13}$$

Moreover, the seller's ex ante expected payoffs are:

$$\Pi^A = \begin{cases} \frac{(1-\theta_0)\overline{\pi}^{A,h}}{(1-\delta_S)(1-\gamma\theta_0\delta_S)} \equiv \Pi^{A,h} & \text{if} \quad r^l \leq r^h\hat{r}, \\ \frac{(1-\theta_0)\overline{\pi}^{A,l}}{(1-\delta_S)(1-\theta_0\delta_S)} \equiv \Pi^{A,l} & \text{if} \quad r^l > r^h\hat{r}. \end{cases} \tag{A.14}$$

PROOF. The expressions in (A.12) and (A.13) are obtained from solving the maximization problem in (1) for the respective transfer strategy $T^A \in \{T^{A,l}, T^{A,h}\}$. For the case where $T^A = T^{A,h}$, the seller's ex ante expected payoffs from conducting an infinite sequence of transactions on A-terms can be derived from solving the following dynamic programming problem for $V_0^{A,h}$:

$$\begin{aligned} V_0^{A,h} &= (1-\theta_0)\left[\overline{\pi}^{A,h} + \delta_S V_1^{A,h}\right] + \theta_0\delta_S V_0^{A,h}, \\ V_1^{A,h} &= \gamma[\overline{\pi}^{A,h} + \delta_S V_1^{A,h}] + (1-\gamma)V_0^{A,h}. \end{aligned}$$

Alternatively, in the situation where $T^A = T^{A,l}$ the ex ante expected payoffs are derived from the following problem:

$$\begin{aligned} V_0^{A,l} &= (1-\theta_0)\left[\overline{\pi}^{A,l} + \delta_S V_1^{A,l}\right] + \theta_0\delta_S V_0^{A,l}, \\ V_1^{A,l} &= \overline{\pi}^{A,l} + \delta_S V_1^{A,l}. \end{aligned}$$

The solutions to the respective programming problem are given in (A.14). Moreover, note that the seller prefers to set $T^{A,h}$ instead of $T^{A,l}$ if and only if $\Delta\Pi \equiv \Pi^{A,h} - \Pi^{A,l} > 0$, which is equivalent to $r^l \leq r^h\hat{r}$. An important requirement for $\hat{r} \in (0,1)$ is $\delta_B \geq r^l/r_E$. Otherwise, setting the transfer to T^l is profit-dominant for the seller and under no revenue shock distribution will he find it optimal to set $T^{A,h}$. □

The lemma shows that even though setting the smaller transfer $T^{A,l}$ implies smaller optimal trade volumes ($Q^{A,l} < Q^{A,h}$) and, correspondingly, smaller stage payoffs ($\overline{\pi}^{A,l} < \overline{\pi}^{A,h}$) doing so can be optimal for the seller. When the size of the negative revenue shock in the r^l-state is not sufficiently pronounced (i.e., when $r^l > r^h\hat{r}$ holds) the seller prioritizes relationship stability over full rent-extraction, which he implements by choosing the smaller transfer level $T^{A,l}$.

Equivalently to Lemma 1, the following result rules out the nonshipment deviation by the seller. Since continuation payoffs depend on the chosen transfer strategy, each transfer scenario features distinct parameter thresholds to rule out the deviation. In Lemma A.2, we use the index $i \in \{l, h\}$ to refer to the low and high transfer strategy, respectively.

LEMMA A.2. *Consider transfer strategy $i \in \{l, h\}$. Suppose that $\alpha > \tilde{\alpha}^i \in (0,1)$ holds. Then there exists an equilibrium of the repeated game where the seller's payoff is Π^A—his maximum ex-ante payoff under cash-in-advance terms—for all $\delta_S \geq \tilde{\delta}_S^i \in (0,1)$.*

PROOF. At the Production and Shipment stage of any period the seller will not deviate from the contract if and only if:

$$-cQ^{A,i} + \delta_S V_1^{A,i} \geq \delta_S V_0^{A,i}, \qquad i = l, h. \tag{A.15}$$

Equation (A.15) follows from the same logic as (IC_S). Plugging explicit values for $V_0^{A,i}$ and $V_1^{A,i}$ into (A.15) and simplifying gives:

$$-cQ^{A,h} + \delta_S \frac{(1-\theta_0+\gamma\theta_0(1-\delta_S))\overline{\pi}^{A,h}}{(1-\delta_S)(1-\gamma\theta_0\delta_S)} \geq \delta_S \tfrac{(1-\theta_0)\overline{\pi}^{A,h}}{(1-\delta_S)(1-\gamma\theta_0\delta_S)} \quad \text{for} \quad i = h, \tag{A.16}$$

$$\text{and} \quad -cQ^{A,l} + \delta_S \frac{\overline{\pi}^{A,l}}{1-\delta_S} \geq \delta_S \tfrac{(1-\theta_0)\overline{\pi}^{A,l}}{(1-\delta_S)(1-\theta_0\delta_S)} \quad \text{for} \quad i = l. \tag{A.17}$$

Observing that $cQ^{A,i} = \overline{\pi}^{A,i}(1-\alpha)/\alpha$, $i = l, h$, we can simplify (A.16) to:

$$\delta_S \geq \frac{1-\alpha}{\gamma\theta_0} \equiv \tilde{\delta}_S^h.$$

For an equilibrium to exist, we need to ensure that $\tilde{\delta}_S^h < 1$. This is the case whenever $\alpha > 1 - \gamma\theta_0 \equiv \tilde{\alpha}^h \in (0,1)$ holds. In this situation, the nonproduction deviation of the seller can be ruled if he is patient enough, that is, when $\delta_S \geq \tilde{\delta}_S^h$ holds. Moreover, we can simplify (A.17) to:

$$\delta_S \geq \frac{1-\alpha}{\theta_0} \equiv \tilde{\delta}_S^l,$$

and ensure that $\tilde{\delta}_S^l < 1$ by imposing that $\alpha > 1 - \theta_0 \equiv \tilde{\alpha}^l \in (0,1)$ holds. □

Under the conditions of Lemmas A.1 and A.2, Proposition 1 applies analogously for both transfer strategies discussed in this extension.

A.7.2. *Open account terms.* The seller's set of participation, liquidity, and incentive constraints remains structurally fully equivalent to the expressions in the main text. As a consequence, the pooling nature of the optimal spot contract—and hence the belief formation and updating process—remain the same. The size of revenue state-contingent transfers and thus the optimal trade volumes change, however. We summarize the principal changes under the generalized revenue shock distribution in the following Lemma A.3. It is the equivalent to Lemma 2 and ensures that the buyer behaves according to the strategy profile, while maximizing the seller's stage game payoffs.

LEMMA A.3. *Suppose that $\delta_B \geq r^l/r_E \in (0,1)$. Then under Ω-terms, the seller sets transfers $T_t^{\Omega,l} = R(Q_t, r^l)$ and $T_t^{\Omega,h} = \delta_B\gamma/(1-\delta_B(1-\gamma))R(Q_t, r^h)$. Thereby, he rules out the buyer bankruptcy risk, makes the patient buyer indifferent between paying and not paying the agreed upon transfer in any revenue state and maximizes his own payoffs.*

PROOF. The proof of Lemma 2 applies. In addition, to ensure that $T_t^{\Omega,h} \geq T_t^{\Omega,l}$ holds (which is used to incentivize buyer payment in any revenue state) we plug the explicit transfer levels into the expression which—after simplification—gives $\delta_B \geq r^l/r_E$. □

Note that the generalized revenue shock distribution additionally requires that the patient buyer has a discount factor above a positive threshold level, that is, $\delta_B \geq r^l/r_E$. This accounts for the additional nonpayment deviation that becomes available to the buyer when $T^{\Omega,l} > 0$.

Acknowledging the results of Lemma A.3, the seller chooses the trade volume in period t by maximizing:

$$Q_t^{\Omega} \equiv \arg\max_{Q_t} \delta_S \Lambda_t \left[\frac{\delta_B \gamma^2}{1-\delta_B(1-\gamma)} R(Q_t, r^h) + (1-\gamma) R(Q_t, r^l) \right] - cQ_t.$$

The optimal trade volume Q_t^{Ω} and the corresponding stage game payoff π_t^{Ω} in the tth transaction with a buyer on open account terms can be calculated as:

$$Q_t^{\Omega} = \left(\frac{\delta_S \mathcal{T}'}{c} \Lambda_t \right)^{\frac{1}{\alpha}}, \qquad \pi_t^{\Omega} = Q_t^{\Omega} \frac{c\alpha}{1-\alpha}, \qquad \text{where} \quad \mathcal{T}' = \frac{\delta_B \gamma^2}{1-\delta_B(1-\gamma)} r^h + (1-\gamma) r^l.$$

The derivation of the seller's ex ante expected payoffs is fully analogous to the main text. Moreover, Proposition 2 applies analogously.

A.8. *Court Usage and Relationship Stability.* In this appendix, we investigate the situation where the seller can observe when institutions (i.e., courts) are used to enforce contract compliance by the buyer. This scenario is equivalent to a situation in which the seller decides to resort to courts in case of buyer nonpayment. Since under A-terms only patient buyers accept the stage contract who—by construction—always comply with the contract terms, the analysis will not be affected in this payment scenario.

The situation changes under Ω-terms, however. Although the buyer's participation and incentive constraints remain unvaried and therefore Lemma 2 applicable, the updating process of the seller's belief θ_t, trade volumes, stage payoffs, and the corresponding dynamic programming problem are subject to change. At the end of the first transaction with a buyer, the seller will know with certainty whether he is in a match with a patient or myopic buyer. The reason is that whenever a transaction with a myopic buyer is successful, it must be the case that buyer payment is enforced by court (she would never pay voluntarily). Contrarily, nonpayment by the buyer will only occur if the buyer is myopic.

Hence, whenever an initial transaction is successful without the usage of courts (which happens if and only if the buyer is patient), the seller updates his belief from $\theta_0 = \hat{\theta}$ to $\theta_1 = 0$.

Correspondingly, trade volumes and stage payoffs grow from Q_0^{Ω} and π_0^{Ω} in the first transaction to Q^{Ω} and $\overline{\pi}^{\Omega}$ in the second transaction, respectively. Consistent with the findings by Macaulay (1963), we assume in the following that the seller discontinues the trade relationship once courts are used to enforce the transfer payment by the buyer. This gives rise to the following dynamic programming problem for the seller:

$$V_0^{\Omega,c} = \pi_0^{\Omega} + \delta_S\big[(1-\theta_0)V_1^{\Omega,c} + \theta_0 V_0^{\Omega,c}\big],$$
$$V_1^{\Omega,c} = \overline{\pi}^{\Omega} + \delta_S V_1^{\Omega,c},$$

which we can solve for $V_0^{\Omega,c}$ to obtain the seller's ex ante expected payoffs:

$$\Pi^{\Omega,c} = \frac{\overline{\pi}^{\Omega}}{1-\delta_S} - \frac{\overline{\pi}^{\Omega} - \pi_0^{\Omega}}{1-\delta_S\theta_0}.$$

Although under the varied model assumptions the belief updating process by the seller is the same under A- and Ω-terms and all information about the buyer is revealed until the end of the initial transaction, the qualitative predictions on trade volume growth and relationship stability of the main text remain valid. Since also under the varied assumptions the stage contract under Ω-terms cannot separate buyer types, just as in our baseline model, we see trade volume growth over time (whereas in contrast, trade volumes on A-terms do not vary over transactions). However, a difference is that due to the additional observability of court usage, the trade volume at the full information limit is reached already after the initial transaction.

Moreover, just as in the main text scenario the probability of relationship failure in any period is larger under A-terms than it is under Ω-terms. Under Ω-terms, a relationship fails after the initial transaction if and only if the buyer is myopic. Under A-terms, relationship breakdown additionally occurs when the patient buyer suffers bankruptcy (which does not occur under Ω-terms in equilibrium). Summing up, we find that our main results are qualitatively robust to assuming that the business relationship dies whenever courts are used to enforce the stage contract.

A.9. *Generalizing the Myopic Buyer Type.* In this appendix, we study the consequences of relaxing the assumption of a fully myopic impatient buyer for our results. More specifically, we generalize the analysis of Section 3 to the situation where the myopic buyer can possess any discount factor $\delta_M \in [0, \delta_B)$.

A.9.1. *Cash-in-advance terms.* As outlined in the main text, when $\delta_M = 0$ the seller always offers a separating contract to buyers that only the patient type accepts. The reason is that a pooling contract would require $T_t = 0$, which is never incentive compatible for the seller. However, this may differ when $\delta_M > 0$, in which case, contracts with positive transfers that ensure $(\mathrm{PC}_{M,t}^{A})$ to hold are feasible.

In order to derive the pooling equilibrium under cash in advance let us note that the role of the liquidity constraints does not change when compared to Subsection 3.1, implying that either buyer type suffers bankruptcy when hit by a low revenue shock (as in the main text, we assume that θ_0 is sufficiently low such that buyer bankruptcy is incentive-compatible for the seller).

Under pooling, it is optimal for the seller to set the transfer such that $(\mathrm{PC}_{M,t}^{A})$ binds with equality. Hence, $T_t^{A,p} = \delta_M R(Q_t, r_E)$. We use $T_t^{A,p}$ for the maximization problem in (1) to determine optimal trade volumes and the corresponding stage payoffs for the pooling case:

$$Q^{A,p} = \left(\frac{\gamma\delta_M}{c}\right)^{\frac{1}{\alpha}}, \qquad \overline{\pi}^{A,p} \equiv \pi_t^{A,p} = Q^{A,p}\frac{c\alpha}{1-\alpha}.$$

Since trade volumes are the same in any transaction and both revenue realizations imply the same payoff for the seller with any buyer, his ex ante expected payoffs under pooling are $\Pi^{A,p} = \overline{\pi}^{A,p}/(1-\delta_S)$.

Observe that (IC_S) is never satisfied under pooling and after receiving the transfer $T_t^{A,p}$ the seller has no incentive to produce and ship the product. Anticipating the seller's commitment problem, the buyer never accepts a cash-in-advance contract on pooling terms. We summarize our findings in the following lemma.

LEMMA A.4. *When using A-terms, for any $\delta_M \in [0, \delta_B)$ it is payoff-maximizing for the seller to offer a stage contract $\{Q^A, T_t^A, A\}$ that separates buyer types. A pooling contract is never optimal and the main text analysis applies for any value of δ_M.*

A.9.2. *Open account terms.* When δ_M is sufficiently large (i.e., sufficiently close to δ_B), it may be profitable for the seller to set transfers such that payment is incentive compatible for the myopic buyer. Such a policy change may be a profitable for the seller as it eliminates the risk of nonpayment by the myopic buyer, which we discuss in Subsection 3.2.

Suppose that the seller designs a contract such that the myopic buyer is incentivized to repay the trade credit. In this case, the myopic buyer's participation constraint is identical to ($PC_{B,t}^{\Omega}$) from the main text. The determination of the optimal transfer strategy follows the same steps as in Lemma 2 with the exception that the transfer in the high revenue state is set such that ($IC_{M,t}^{\Omega,h}$) instead of ($IC_{B,t}^{\Omega,h}$) binds with equality, which gives $\hat{T}_t^{\Omega,h} = \delta_M\gamma/(1-\delta_M(1-\gamma))R(Q_t)$. Moreover, $\hat{T}_t^{\Omega,l} = T_t^{\Omega,l}$.

Acknowledging this transfer strategy, the seller chooses the trade volume in period t by maximizing:

$$\hat{Q}_t^{\Omega} \equiv \arg\max_{Q_t} \delta_S \hat{\Lambda}_t \hat{\mathcal{T}} R(Q_t) - cQ_t, \qquad \text{where} \quad \hat{\mathcal{T}} = \frac{\delta_M\gamma^2}{1-\delta_M(1-\gamma)}.$$

Since $\hat{\Lambda}_t = 1$ in this case, the optimal trade volume $\hat{Q}^{\Omega}$ and the corresponding stage game payoff $\hat{\pi}^{\Omega}$ are the same in every transaction under this transfer strategy and given as:

$$\hat{Q}^{\Omega} = \left(\frac{\delta_S\hat{\mathcal{T}}}{c}\right)^{\frac{1}{\alpha}}, \qquad \hat{\pi}^{\Omega} = \hat{Q}^{\Omega}\frac{c\alpha}{1-\alpha},$$

yielding $\hat{\Pi}^{\Omega} = \hat{\pi}^{\Omega}/(1-\delta_S)$ as the seller's ex ante expected payoffs. Note that whether or not this transfer strategy is optimal, it sustains the finding from the main text that the optimal contract under open account terms pools buyer types.

When we compare the seller's outcome from this alternative transfer strategy to the outcomes in the main text scenario we obtain the following result.

LEMMA A.5. *There exists a unique $\delta_M^* \in (0, \delta_B)$ such that $\{T_t^{\Omega,l}, T_t^{\Omega,h}\}$ is the optimal transfer strategy for the seller for all $\delta_M < \delta_M^*$. Otherwise, $\{\hat{T}_t^{\Omega,l}, \hat{T}_t^{\Omega,h}\}$ is the optimal transfer strategy.*

PROOF. The result is obtained from comparing $\hat{\Pi}^{\Omega}$ and Π^{Ω}. First, note that Π^{Ω} is independent of δ_M. Moreover, observing that $\partial\hat{\Pi}^{\Omega}/\partial\delta_M > 0$, $\Pi^{\Omega} > \lim_{\delta_M\to 0}\hat{\Pi}^{\Omega}$, and $\Pi^{\Omega} < \lim_{\delta_M\to\delta_B}\hat{\Pi}^{\Omega}$ completes the proof. □

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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